WILSON ORNITHOLOGICAL CLUB

The American Biology Teacher

VOL. 1 MAY, 1939 NO. 8

Science in the World Crisis
- - - - Edwin G. Conklin 171
Viruses in Plants - L. M. Black 175
Modeling in the Laboratory
- - - - M. Anthony Payne 181
Embryonic Material for
Laboratory Experimentation
- - - - - - - Roberts Rugh 184
President's Message - - - - - - 188
Association Notes - - - - - - 189
Biological Briefs - - - - - - - 191
Biology Teaching Aids - - - 192
Books - - - - - - - - - - - 199
Index to Volume 1 - - - - - - 203

PUBLISHED BY
The National Association of Biology Teachers

NOW WE CAN FILL YOUR ORDERS with . . . .

AMERICAN MADE DISSECTING INSTRUMENTS

We are now in a position to supply your needs for student dissecting instruments and kits with **AMERICAN MADE** products . . . it has required considerable time and effort, to say nothing of expense, to develop these instruments to a point where they could be considered up to the **ADAMS** standard, but we believe you will agree with us that our efforts have been well rewarded by instruments of excellent quality and design.

Take as an example, the **A-1** and **A-1Y** scalpels illustrated above . . . the handles are made of Bakelite, an innovation in the use of materials for dissecting instruments . . . they give the scalpels perfect balance, convenient handling size and texture. Then add to the handle, a scalpel blade of highest grade cutlery steel, and you have an **ADAMS AMERICAN MADE DISSECTING INSTRUMENT.** The same attention to detail has been given to all other instruments in this series.

May we quote on your requirements for dissecting instruments?

CLAY-ADAMS CO., INC.
44 EAST 23RD STREET, NEW YORK

Send for a copy of Cat. AB125 which describes dissecting instruments and laboratory supplies.

FOR SIMPLIFIED
PRACTICAL TRAINING

B&L TYPE H MICROSCOPE

B&L BALOPTICONS

B&L Type H Microscopes are similar in all operating essentials to the instruments used in science and industry; they also are invaluable in familiarizing the student with microscopical technique he may be called upon to use in his business or professional life. For full information send for Catalog D-185.

B&L Balopticons, projecting vivid story telling pictures or diagrams so that an entire group can see, have amply demonstrated their usefulness in teaching students of all ages. For complete specifications of all models write for Catalog E-11. Bausch & Lomb Optical Co., 718 St. Paul St., Rochester, N. Y.

BAUSCH & LOMB

STANSCIEN WARMING TABLE

New—Improved—Reliable

No. 6601

USES: Spreading Paraffin Sections—Keeps Stains and Reagents at Constant Temperatures

RELIABLE: Thermostatically Controlled up to 80° C.—Heavy Copper Plate Insures Uniform Heat

Equipped with Pilot Light—On and Off Switch—Cord and Plug

Rigid Construction

Convenient Size, 9 x 20 x 4½″

Easy to operate—For Use with 110 Volts A.C. and D.C.

No. 6601: Price with thermometer $28.00
Cover for Dust Protection 5.00

STANDARD SCIENTIFIC SUPPLY CORP.
34–38 West 4th Street, New York, N. Y.

SERVING HIGH SCHOOL BIOLOGISTS

MICRO-SLIDES for the High School Biology student *must be typical* preparations of the finest quality. They must show structures clearly, be easy to demonstrate and they must teach.

WARD'S slides are all of the above. Our micro-technique laboratory specializes in carefully made preparations for high school use.

ORDER a selection of micro-slides on approval. If you are not well pleased your money will be cheerfully refunded.

Ask us to send your copy of Catalog H-391, THE HIGH SCHOOL SCIENCES.

WARD'S NATURAL SCIENCE ESTABLISHMENT, INC.
EST 1862
312 W. Goodman St., Rochester, N. Y.
THE HENRY A. WARD FOUNDATION OF NATURAL SCIENCE OF THE UNIVERSITY OF ROCHESTER

THE AMERICAN BIOLOGY TEACHER

Publication of The National Association of Biology Teachers.
Issued monthly eight times during the school year from October to May.
Publication Office—N. Queen St. and McGovern Ave., Lancaster, Pennsylvania.
Correspondence concerning manuscripts may be addressed to any of the Associate editors or directly to the editor-in-chief.

Association Officers

President: M. C. Lichtenwalter, Lane Technical High School, Chicago, Illinois.

President-elect: Malcolm D. Campbell, Dorchester High School for Boys, Boston, Massachusetts.

First Vice President: George W. Jeffers, State Teachers' College, Farmville, Virginia.

Second Vice President: Lucy Orenstein, Evander Childs High School, New York, New York.

Secretary-Treasurer: P. K. Houdek, Township High School, Robinson, Illinois.

Editorial Staff

Editor-in-Chief (acting):

I. Alex. Herskowitz
Christopher Columbus High School
Bronxwood and Waring Avenues
Bronx, New York City

Managing Editor:

J. S. Mitchell
University High School
Lexington, Kentucky

Assistant Managing Editors:

Alex. A. Fried
Christopher Columbus High School
New York City

I. P. Daniel
Lake View High School
Chicago, Illinois

Associate Editors

Herman C. Arneson
Bemidji High School
Pelican Rapids, Minn.

Peter A. Blate
109 Hyde Park Pl.
Tampa, Florida

Willis W. Collins
Idabel High School
Idabel, Oklahoma

L. C. Dingess
Yuma High School
Yuma, Arizona

Ruth A. Dodge
Johnstown High School
Johnstown, New York

Philip E. Foss
Hartford Public High School
Hartford, Connecticut

Elwood D. Heiss
State Teachers College
East Stroudsburg, Pennsylvania

Melvin A. Hintz
South Milwaukee High School
South Milwaukee, Wisconsin

Charles C. Herbst
Beverly Hills High School
Beverly Hills, California

Ray Kennelty
Du Bois High School
Du Bois, Pennsylvania

M. C. Lichtenwalter
Lane Technical High School
Chicago, Illinois

Helen G. Mank
Lawrence High School
Lawrence, Massachusetts

Thomas F. Morrison
Milton Academy
Milton, Massachusetts

M. A. Russell
Junior High School
Highland Park, Michigan

Ruth Sherman
David Starr Jordan High School
Los Angeles, California

J. L. Sloanaker
North Central High School
Spokane, Washington

J. A. Trent
State Teachers College
Pittsburg, Kansas

B. Bernarr Vance
Kiser High School
Dayton, Ohio

Guy F. Williams
Colby Junior College
New London, New Hampshire

Advisory Staff

E. V. Cowdry, Washington University, St. Louis, Missouri.

W. C. Curtis, Univ. of Missouri, Columbia, Mo.

B. C. Gruenberg, Sub-Treasury Bldg., New York City.

George W. Hunter, Claremont College, Claremont, California.

Paul B. Mann, Evander Childs High School, 800 Gun Hill Rd., New York City.

D. F. Miller, Ohio State University, Columbus, Ohio.

Oscar Riddle, Carnegie Institute, Cold Spring Harbor, Long Island.

Edmund V. Sinnott, Columbia University, New York City.

Entered as second-class matter October 26, 1938, at the post office at Lancaster, Pa., under the Act of March 3, 1879.

QH426
.A53
5-40

The American Biology Teacher

Vol. 1 MAY, 1939 No. 8

Science in the World Crisis*

EDWIN G. CONKLIN
Princeton University

There is at present a rising tide of denunciation of Science for having produced the disorders of society and the savagery of modern wars that are threatening the destruction of the fairest products of civilization. The outcry against science was begun by theologians of several centuries ago; it was continued by defenders of classical education during the past hundred years; and since the beginnings of this century it has been taken up by the self-styled "Humanists." Of late there are signs that all these denunciations of science as the destroyer of peace, progress and ethical values have begun to influence the minds of the masses of mankind.

There is no need at this time to go back to the ancient antagonisms of theology nor even to the outcry of the classicists, who realized that the growth of science in education was endangering their occupation and who now see their dire predictions verified—forgetting that wars and savagery antedated the scientific era and indeed flourished even in classical times, when there was no science to bear the blame.

Advocates of the humanities are now having their innings and their cheer leaders are working up enthusiasm for their side by denouncing science as the cause of all our wars. Science is knowledge, and with Milton they trace all the ills of the world to "The fruit of that forbidden tree (of knowledge) whose mortal taste brought death into the world and all our woe." More than 40 years ago Woodrow Wilson discoursed eloquently on "The Bankruptcy of Science" and within the last decade Christian Gauss has warned us of "The Threat of Science," and numerous other advocates of the humanities have proclaimed that civilization must be saved by curbing or removing science and by promoting "humanism." In general this movement represents an emotional revolt against the aims, methods and results of science, a revolt against scientific evidence and unwelcome facts, and a resort to undefined emotions and intuitions. Schoolboards, trustees and administrators are

* Address before the New York Science Teachers' Association, Hotel Astor, February 25, 1939.

feeling this pressure against the teaching of science; parents and pupils are being persuaded and warned, and some churches are thundering their denunciations. One week ago (*New York Times,* Feb. 19, 1939) Dr. C. J. McCombe warned the National Conference of Christians and Jews that curbs on science are urgently needed, and that it may become a Frankenstein monster if unchecked.

All of this denunciation of science might leave science teachers cold if it were not for the fact that here as in every other conflict of ideas and ideals "Eternal vigilance is the price of liberty." The ancient conflict between science and theology was not settled by "letting nature take its course" but by the heroic defense made by men of science. The contest between the old classical and the new scientific education was ended by the heroic work of science teachers aided by the common sense of the public. I have in the long past modestly defended science against all these non-scientific attacks and have maintained the thesis that science is the most liberalizing, civilizing and humanizing of all educational disciplines. And yet I am bound to confess that, in spite of ever increasing attention to science in general education, I have seen an alarming growth of emotionalism, intolerance and brutality among nations in which science has been most advanced.

As science teachers it behooves us to consider seriously what may be the cause of this. Is it due to the fact that science teaching has not yet begun to affect the majority of people in these nations? No doubt the mass of the people in the nations most highly trained in science are lacking in the spirit of openmindedness, tolerance, and fair play, the spirit of sweet reasonableness and earnest seeking after truth which is universally recognized as the true spirit of science. Millions of the younger persons in these nations have been exposed to the liberalizing influence of science teaching, and yet the "youth movement" in these nations is generally the most intolerant and unscientific of all. Why has the teaching of science had so little influence upon these young Hotspurs? Why do whole nations of civilized people still decide the most important acts of their lives without regard to scientific facts, evidence, reason or truth? Why do whole populations, in spite of scientific education, remain fundamentally unscientific?

Of course the answer to this question is the same as to the often asked question, Why do not Christian nations practice the principles of Christianity? It is primarily because of the fact that neither the principles of science nor of Christianity enter into the characters of those who profess adherence to them. They never get beneath the skin; they are not even skin-deep but only clothes-deep. It is not the fault of science nor of Christianity that their principles do not govern the lives of men. Nothing is wrong with science itself for science is verifiable knowledge and its aim is the search for truth. Few if any of the critics of science would dare to denounce truth or the search for it.

What, if anything, is wrong with the teaching of science, and the inculcation of the scientific spirit? At once I disclaim any thought of an examination of the details of science teaching, whether in Biology, with which I am acquainted, or in Physics, Chemistry and other sciences, with which I am less familiar. Such details are discussed *ad infinitum* and *ad*

nauseatum in pedagogical seminaries and teachers' meetings. In general it may be said that there is no *one best way* of teaching any subject. What is best for one teacher or pupil or place may not be best under other conditions. Let us forget for the time such variables and consider the constants in our problem, namely, what is wrong with science teaching in general?

A principal fault, I think, is the general lack on the part of science teachers of a constant social and ethical aim in teaching. We have been obsessed with the idea of "science for science sake." Like that famous Cambridge toast, "Here's to mathematics, may it never be of use to anyone," we have felt that the dignity of our science demands that it be taught and pursued for the sake of abstract truth. When we have emphasized use it has almost always been external, objective use; the harnessing of the forces of nature, the increase of human power and comfort, the conquest of disease. These objective uses of science are vastly important, but they are not the most important service of science, which in my opinion is the cultivation of the spirit of science in the student. The subjective or disciplinary uses of science studies are frequently derided and in up-to-date education are thought to have gone out with the old-fashioned study of Latin, Greek and Mathematics. But in my opinion this is a fundamental mistake. Real discipline is by all odds the most important aim of all education.

What is education? Strange as it may seem educators seldom ask themselves this question, and when they do they often answer that it is conveying information and preparing students to pass examinations on the information they have acquired. We generally assume that we are successful teachers when our pupils are able on examination to give back to us in more or less mutilated form the information which we have given to them. And yet we know from our own experience that this is largely a training of memory and that within a short time most or all of this information will be forgotten. Some times our students are able to remember what they have learned until examination but they promptly forget it thereafter. I once heard President Eliot of Harvard say that entrance examinations to college had now reached such a height that he would be afraid to take such an examination and President Gilman of Johns Hopkins said he knew he would fail. If the imparting of information is the chief aim of education, then it is a dismal failure as measured by its results.

Suppose we look at education in a matter-of-fact, scientific way. As measured by its products what are its enduring results? When alumni come back to reunions, what are the things which remain in their memories? Is it what they learned in preparation for examinations? What do they discuss with one another and with their old teachers? Certainly not the detailed information which they so painfully acquired. As a teacher of more than fifty years' experience I am continually surprised when my former students tell me of the things which most impressed them in my teaching. They tell me of casual words, deeds, ideas and ideals which have deeply influenced them and of which I usually have no remembrance. It often makes me think of the scriptural warning, "For every idle word that men shall speak they shall be brought into judgment." Evidently my example has had a more lasting effect on my stu-

dents than all the information I labored to impart.

What then are the enduring effects of education? I believe the most important effects, perhaps the only lasting ones, are the formation of good habits of body, mind and morals. Philologists say that 'education means drawing out,' but as a biologist I should say that education is an attempt to stimulate and control development, which amounts perhaps to the same thing,—the drawing out of innate capacities. Heredity determines capacities and possibilities of development, but these possibilities would forever remain unrealized if they were not stimulated to develop by environment, use, training. At the beginning of life every human being is a bundle of inherited possibilities, which differ greatly in different individuals. Which of these possibilities will become realities depends upon environmental stimuli. All development is brought about by the response of the organism to such stimuli. In every human being there are many alternative personalities. Each of us might have been very different from what we are under different conditions of development. Instead of being science teachers we might have been almost anything else. Our particular social activities and positions depend more upon social stimuli than upon heredity.

Stimuli and responses oft repeated become habits, and according to the maxim, 'habits are second nature,' while heredity is first nature. We are creatures of habit no less than of heredity. We cannot change our heredity; that was absolutely fixed at the time of the fertilization of the egg from which each of us came. But stimuli, responses and habits can be changed, and as I have said the most important, if not the only lasting effect of education is habit-forming.

It is the paramount duty of teachers to help pupils to acquire good habits and to avoid bad ones. By proper stimuli, example, inspiration we can help pupils to develop good habits of body, mind and morals,—skill instead of bungling, industry instead of sloth, accuracy instead of inaccuracy, success instead of failure, sincerity instead of pretense, tolerance instead of intolerance, sympathy instead of hatred.

How much the world needs these good habits, how much it suffers from these bad ones is illustrated on every hand. The present world crisis is largely caused by the deliberate training of people in bad habits of hate, intolerance, insincerity, habits of aggression, robbery, greed, brutality, murder, war. The present world crisis is not due to bad heredity, nor original sin, nor the Devil, but to bad habits of fear, intolerance, and hate of races, religions, nations and ideologies which emotions have been deliberately inculcated. The peace and progress of mankind depend on acquiring habits that make for peace and progress.

This should be the aim of all education. What then is the peculiar advantage of science teaching? It is especially valuable in cultivating habits of accuracy, independence, critical judgment; ability to distinguish reason from emotion, truth from propaganda, evidence from ballyhoo; cultivation of humility and modesty in the face of the vast unknown and recognition of the fact that all knowledge is incomplete and capable of improvement; aesthetic appreciation of beauty, order, and truth; ethical devotion to sympathy, service and fellowship.

Science teaching is especially fitted to teach such habits if the teacher keeps in mind these social and ethical aims. These

(Continued on page 206)

Viruses in Plants

L. M. BLACK
The Rockefeller Institute for Medical Research, Princeton, N. J.

Introduction

Many people are unaware that plants have diseases,—that they are afflicted by the same pathogenic agents as attack animals and man. Fungi, bacteria, viruses, insects, and nematodes are important agents causing plant maladies. Plants also suffer from serious deficiency diseases. For example, a whole host of plant diseases recently have been shown to arise from an insufficiency of boron.

The study of viruses in plants is an intensely interesting one. In 1898, Beijerinck discovered that the infectious agent in juice from tobacco plants affected with mosaic disease could readily pass through filters that would hold back bacteria. As time passed, and more and more juices capable of initiating disease were tested, it became apparent that a considerable group of pathogens possessed this property. These agents also possessed in common the characteristics of being invisible under the microscope and of being unable to grow on any medium which did not contain living cells. This latter attribute made it necessary to develop a technique of handling viruses quite dissimilar in important respects from the bacteriological techniques developed earlier.

Symptoms

The symptoms produced in plants invaded by viruses are extremely variable. In the first place, the environment exerts a profound influence upon symptom expression. For example, the temperature at which the plants are growing may determine whether they will show any symptoms at all, even though they have been completely invaded by the virus. The most common first symptom of virus infection in plants consists of a clearing of the veins of the young leaves. The veins become more prominent, wider, lighter in color, or translucent. Leaves that are mature at the time the virus enters the plant seldom develop symptoms. The new leaves may be mottled by a mosaic of light and dark green areas, this condition persisting through the normal life span of the plant. Sometimes concentric light yellow rings appear on the leaf surface. Leaves may be blistered, puckered, curled, or otherwise distorted. In some diseases numerous shoots are produced. Potato plants may have so many miniature stalks that they look like moss on the ground. In other diseases the leaves, or even the whole plant, may be rapidly killed. In some cases the diseased plants may look stronger and more vigorous than the healthy plants, but they may yield poorly. In other plant virus diseases, after an initial phase in which symptoms are plainly evident, there regularly follows a stage in which practically no symptoms are discernible. However, virus can still be obtained from these recovered plants.

This is but a partial list of symptoms found on leaves. Flowers, fruits, and underground organs also show a great variety of symptoms. An interesting case is that of certain prized tulip varieties where the petals are streaked with red and white. These are nothing but red varieties infected with one of the

tulip viruses. These special "varieties" of tulips are described in literature of the 16th century.

Economic Importance

Certain of the plant virus diseases are of tremendous economic importance. One of the outstanding cases in the United States is that of curly top of beets. The virus of this disease is transmitted by a leaf-hopper which in certain years spreads in great numbers from its breeding areas to the sugar beet fields. The beet crop in whole districts has sometimes been a complete failure and sugar beet factories were forced to dismantle and move elsewhere. Similarly, raspberry culture seems to have been abandoned in certain areas because of virus invasion. Spotted wilt virus makes the growing of tomatoes impossible in certain regions. The aster yellows virus made the culture of asters a practical impossibility in many sections. Numerous other instances could be cited.

The problem of potato degeneration can be taken as an example of the importance and mystery of certain diseases that attracted attention to the viruses. The degeneration of potatoes or their decline in vigor and yield in certain areas is not a new phenomenon. Since the earliest days of general potato culture by the western nations, this degeneration probably occurred. Early nineteenth century English descriptions of degenerated potatoes leave little doubt as to the virus nature of the trouble. One of the interesting features of the degeneration of the potato plant was its geographic localization. The more northerly countries or the regions of high elevation were not troubled seriously by potato degeneration. This knowledge led to a more or less continuous importation of seed potatoes from northern areas to southern areas; e.g., the importation of seed potatoes from Scotland into England. Thus, a partial control of the trouble was worked out with no knowledge as to its true nature. As the word "degeneration" implies, the commonly accepted understanding of the condition was that continuous asexual propagation had a devitalizing influence. Now we know that the degenerated potatoes were infected with one or more viruses. Degeneration proceeded more rapidly in warmer climates because there more plant lice infested the potatoes and spread the viruses from plant to plant. The asexual reproduction of the potato was involved in the degeneration process because the viruses were perpetuated in the seed tubers. If the potato plant began from the true seeds each year, there would be much less chance of degeneration because the transmission of plant viruses through true seed is the exception rather than the rule.

Natural Transmission

The study of the transmission of viruses in the field is an important practical problem. The method by which many plant viruses are transmitted in nature is still to be discovered. Tobacco mosaic virus seems to be disseminated principally by man himself. There is no insect known to transmit this virus efficiently. Workers may accidentally rub juice from chewing tobacco onto the leaves of young plants and thus inoculate them, for it has been shown that some of the best brands of chewing tobacco contain sufficient virus for the purpose. Later the virus is spread from plant to

plant in the various handlings connected with tobacco culture.

Most plant viruses are transmitted by insects. At the beginning of the present century, Japanese workers showed that the virus of dwarf disease of rice was transmitted by a certain species of leafhopper. This was the first demonstrated case of the transmission of a plant virus by an insect. Since that time numerous plant viruses have been shown to be transmitted by insects. Insects that suck the juice from the phloem of plants are the chief offenders. Aphids carry most of the plant viruses known to be insect-borne, but leafhoppers, thrips, and other insects play an important part. In the majority of cases the process of transmission is purely mechanical,—the insect transmitting the virus only as long as its mouth parts are contaminated. This fact should not be forgotten when one is fascinated by the special biological relationships existing between certain viruses and the insects which carry them. In these more interesting cases, the virus may have quite a complex relationship with a specific insect. Thus, after the insect feeds on a diseased plant, an interval of hours or even days may elapse before it is capable of infecting a healthy plant. Some investigators have evidence that the virus multiplies in the insect during this period. Once the insect begins to transmit the virus, it may transmit it for the rest of its life without fresh access to a diseased plant. In one instance it has been clearly demonstrated that the virus passes through the insect egg, but not through the sperm, to the next generation. Sometimes the insect carries the virus through the winter in its body. It has also been demonstrated that within a single species of insect certain individuals are incapable of transmitting the virus, while others do so readily. In the leafhopper that transmits corn streak virus, a single sex-linked Mendelian factor controls this capacity. However, most plant viruses do not exhibit quite such special relationships with their insect carriers and some viruses are spread by numerous insects. It has also been shown that insects may carry a plant virus in their bodies for long periods, even though they are not capable of transmitting the virus. One of the most noteworthy facts about the virus-insect relationship is the absence of any detectable deleterious action by any plant viruses upon the insects carrying them.

The dispersal of viruses is also greatly facilitated by the large number of different kinds of plants which they are capable of invading. Some of the hosts may be biennials or perennials and so serve to carry them through the winter. Other hosts, cultivated or wild, while showing no evidence of disease, may be completely invaded by the virus in high concentration, and thus act as reservoirs from which insects transmit infinitesimal amounts to other plants that are severely damaged. An example of such a reservoir is the common American potato. All commercial varieties in America are 100% infected with a virus that does not produce any disease symptoms whatever in these potatoes.

Transmission in the Laboratory

The only method by which the presence of a virus can be demonstrated in any solution is by means of the infections it is capable of producing in plants. Some of the early methods by which viruses were introduced into plants were crude. To determine whether a plant disease is

transmissible, one of the best tests is to graft a portion of the diseased plant on to a healthy plant of the same kind. Grafting is still indispensable in the study of certain plant viruses today, because this is the only known method of transmission. However, this method has serious handicaps for certain investigations on the virus itself. Presumably the virus in such transfers is always preserved in living protoplasm. One therefore cannot apply to the virus any test that will destroy the protoplasm of the host plant and all the information we gain about the virus is circumscribed by this environment. We cannot say that the virus would behave in the same manner if it were taken out of the host protoplasm. Some of the viruses that are difficult to transmit are also studied in the laboratory by means of the insects that carry them. This method of transmission has the same disadvantage that has been described for grafting.

Many viruses can be transmitted by rubbing the juice from diseased plants over the leaves of healthy plants with cheesecloth. Carborundum is often dusted over the leaf before rubbing to facilitate the transfer by wounding cells on the leaf surface. It is thought that transfer takes place only by the virus entering injured cells that recover or at least remain alive long enough for the virus to gain passage to neighboring uninjured cells. Most studies on viruses were originally based on the number of plants that were infected by a given inoculation. Some viruses make many lesions or "spots" on the inoculated leaves of certain of their hosts. It has been shown that each spot represents a point where the virus has entered the leaf and thus represents an infection. The usefulness of this reaction for quantitative work was demonstrated by Holmes in 1929. Thus, instead of using 200 plants in an experiment, the same number of infections might be obtained on a single leaf of a suitable species.

Classification

In the early days it was not known whether there was one virus infecting plants or many. Investigators trying to clarify this point discovered that viruses could be transmitted from species to species, genus to genus and finally from family to family. It became apparent that there were many plant viruses with widely overlapping host ranges. However, the host ranges of the viruses were not identical and this fact and the different disease symptoms produced by the viruses aided in their separation.

Johnson was one of the first to apply certain physical tests to the viruses for the purpose of differentiating them. For example, he found that the viruses varied in the extent to which they could withstand heating, dilution, or storage in the extracted juice and still be able to produce infection. For a time the study of plant viruses went through a period of intense activity in the describing and naming of new viruses. Great confusion was the result since it was always possible that two investigators were working with the same virus in different host plants. Means of identifying viruses, such as exchanging plant material, were not very satisfactory. However, more recently there has been a trend toward the grouping of some of the plant viruses in a more orderly relationship. Two lines of research have contributed especially to this result.

The identifying and natural grouping

of plant viruses has been facilitated by the development of serological tests similar to the agglutination tests that make blood identification possible. So far this method has been applied successfully to only a few plant viruses but if its use can be extended it promises much for an orderly classification.

Another aid in classification has arisen from the study of virus strains or mutations. Viruses are very much like organisms in the frequency with which they mutate. If one examines 100 tobacco plants infected with tobacco mosaic one will almost certainly find, on some of the plants, leaves with bright yellow spots. If the virus is taken from this one spot and inoculated into healthy plants, the plants will develop tobacco mosaic but a more yellow form of the disease. By this technique and others, literally hundreds of different strains can be obtained. Some kill the plants, some cause severe distortion, some are symptomless. Yet when one goes into the field to obtain tobacco mosaic virus one always finds the same strain in the tobacco fields. Why? The strain in nature is fittest. It spreads from plant to plant more easily and invades each plant more quickly than any of the variants it has thus far produced. And once it has invaded the whole plant, it is difficult or impossible for the other strains to get in, or spread in the plant once they do. However, unrelated viruses gain entrance to the infected plant as readily as ever. Such reactions can, therefore, be used successfully to test and establish relationships and differences between viruses. However, once again it is necessary to add that the method has been applied to a limited number of viruses and several experimental difficulties will have to be overcome to make it of more general applicability.

Control

The control of many of the serious virus diseases has already been accomplished. Breeding plants for resistance to virus disease has probably been the most successful method employed. Workers in the United States Department of Agriculture have produced a sugar beet that gives a normal yield under conditions where the curly-top virus reduces the yield of the old varieties to almost zero. The production of sugar cane in certain Caribbean islands fell to very low levels after sugar cane mosaic virus invaded the islands and rose again with the introduction of disease resistant varieties. Progress is being made in breeding tobacco that for practical purposes will be immune to tobacco mosaic virus.

Methods other than plant breeding have also been employed. Losses from potato viruses have been held in check by a system of inspection and certification of fields in which seed potatoes are produced. Asters, free from aster yellows virus, are now grown commercially under large cages covered with coarse cloth netting which keeps out the leafhopper carrying the virus. Serious losses from cucumber mosaic can be prevented by eradicating weeds around the cucumber fields that provide a reservoir for the virus. Control by what would seem to be the simple and obvious measure of destroying the insects carrying the viruses is often the most difficult to accomplish. In fact, there are comparatively few cases where this method of control has been economically feasible. Each particular disease must be attacked at its most vul-

nerable point and this is usually revealed only after careful study.

Fundamental Nature

Investigations into the fundamental nature of viruses have been conducted ever since Beijerinck's demonstration in 1898 that the virus of the tobacco mosaic disease would pass through bacteria-proof filters. This experiment itself suggested that the viruses were unusually small pathogens—one of the fundamental facts known about viruses. The most significant recent discovery concerning viruses was Stanley's isolation of a crystalline protein material which seems to possess the properties of the tobacco mosaic virus. It is a remarkable chance that this latter finding should have been made with the same virus that first opened men's minds to the ultramicroscopic world of disease-producing agents. Between these two outstanding discoveries there were many less crucial but nevertheless important contributions. Many attempts were made to grow the viruses in lifeless media, but to the present day no one has succeeded in growing a virus in the absence of living cells. Abnormal bodies (inclusion bodies or X-bodies) were discovered in the cells of diseased plants and these were thought by some to represent a non-filterable stage of the virus, by others to be by-products of disease processes. Many of the inclusions resembled organisms. Now it seems evident that these bodies are products of disease processes. However, some of the abnormal bodies, less like organisms in appearance, are almost certainly aggregates of the protein crystals. Ultraviolet light microscopy failed to reveal any probable causal agent in diseased plant cells. Filtration experiments through special membranes and diffusion experiments were used to estimate the size of the plant viruses. It was shown that the virus could be sedimented by centrifugation, and measurements on the rate of settling also permitted estimation of the size of the virus particle. Experiments demonstrated that the juice from tobacco mosaic plants contained colloidal rod-like particles not present in non-infectious juice. The early estimates of virus size were remarkably close to the present figures. Now we know that the protein isolated from diseased plants consists of colloidal particles about 430 millimicrons long and 12.3 millimicrons wide. Convincing serological work was accomplished which indicated that the virus was closely associated with protein. All of these facts and probabilities had been established before 1935 when Stanley's crystallization of active protein in juice from tobacco mosaic plants provided a tangible focus for much of the future research.

Since 1935, many tests have been applied to the protein crystals in an effort to make certain that the protein is the virus and not simply a closely associated substance. Thus far no method has been found by which an active ingredient can be obtained separate from the characteristic protein, the colloidal particles of which are 42 million times as heavy as the hydrogen atom. Moreover, the application of the same methods of isolation to other plant viruses is yielding similar proteins. More recently, the English workers, Bawden and Pirie, have shown that the protein is a nucleoprotein. This is a point of great interest because nucleoproteins occur in the nuclei of cells.

It should be apparent from this brief account that the field of plant viruses is a young and active division of science and that the future probably holds many other interesting discoveries for the investigator.

Modeling in the Laboratory

M. ANTHONY PAYNE
Mount St. Scholastica College, Atchison, Kansas

The science teacher usually experiences many difficulties when trying to impart adequate lucid truth to elementary science students. Time is always limited, students are frequently unresponsive and inattentive, equipment is meager, confreres unappreciative, and the teacher's own store of dynamic enthusiasm and earnest zeal an exquisitely delicate asset that can easily be overdrawn.

In a recent paper[1] several different techniques which can be used in the laboratory to facilitate teaching, and which aid in imparting information were discussed. The use of biological models as teaching assets was especially stressed because models enable students to visualize objects as they exist in nature, that is, in terms of length and breadth and depth. A student sees the three dimensions of flowers or cells or protozoa and forms relatively correct concepts.

An elaboration on various kinds of modeling materials, laboratory technique, and finishing steps may enable students in secondary schools and colleges to make inexpensive, yet very correct and satisfactory models of various objects. Such models can be turned out by the neophyte, with very little help from the instructor, and at a negligible cost to the department.

Materials

Different grades of clay and dry asbestos were used in making the models pictured in the accompanying illustration. The more expensive clay ($0.25 a lb.)[2] is excellent to use for making the delicate parts of models, such as chromosomes (mitotic sets) or the thin-walled cup of a vorticella. The better clays have higher adhesive properties and are more easily manipulated.

A cheap clay that is very satisfactory ($0.05 a lb.)[3], and clay found locally along river fronts or in deep excavations, can be used for many of the models. If the heavy part of the body is made from local clay and a thin layer of commercial clay added, the finishing can be done more easily. Local clays tend to shrink and crack more readily than the commercial clays, but the cracks can be filled with clay or putty and will not show when the models are completed.

Another superior modeling medium, which can be obtained from local plumbers at a nominal cost ($0.02 or so a pound) is dry asbestos. This material is homogeneous and clean to work up, and when dry, is lighter than a similar amount of clay.

Dry asbestos is prepared for modeling by stirring small amounts of it into a quart of water in which a cup of flake glue has previously been dissolved. Asbestos is added until the mass has a consistency of stiff dough. Flake glue (obtained at the hardware store) makes the particles of asbestos adhere together firmly and the models dry with relatively hard surfaces. A thin coating of the dissolved glue, added after the models are thoroughly dry, acts as a sizing or filler.

[1] Payne, M. A. 1938. "The Third Dimension in the Teaching of Biology," *Transactions Kansas Academy of Science*, Vol. 41, 1938, p. 295.

[2] American Art Clay Co., Indianapolis, Indiana, Mexican Pottery Clay.

[3] Red Wing Clay Co., Red Wing, Minnesota.

Thin flat surfaces such as petals or sepals for a diagrammatic flower model can be cut from screen wire, shaped properly, and painted with a thin coat of asbestos. Several coats can be applied, allowing sufficient time between paintings for the previous coat to dry.

Accessory materials, such as wire, cardboard, beads, excelsior, celluloid, and many other items that are potential parts of perfect models, can be salvaged from the school or home basement. Naive ingenuity and unusual resourcefulness on the part of the students are repeatedly brought to light during the interim of modeling periods. The supporting wires for the tentacles of the hydra in the illustration, for example, are wire handles from discarded syrup buckets.

Flat house paint, preferably gray or some light shade, is applied to the models when they are dry. The models are covered completely, and later on a second coat of enamel is added. One can of white enamel and several small tubes of oil paint enable the student to prepare sufficient quantities of colored enamels as they are needed. A basic coat, similar to the color of the living organism or to standard differential stains, is made by adding green, red, or violet, etc., to about half of the can of white enamel. Most of the surface of the model is enameled with this color, and then details of structure painted in harmonious and contrasting shades. One coat of enamel is usually sufficient to give an excellent finish.

The cells illustrating plant mitosis, for example, are painted a light green; the cell walls, plastids, and cytoplasmic inclusions, various shades of darker green; the spindles are a yellow-green, the spindle fibers, gray, the chromosomes, blue, and the karyosome, orange.

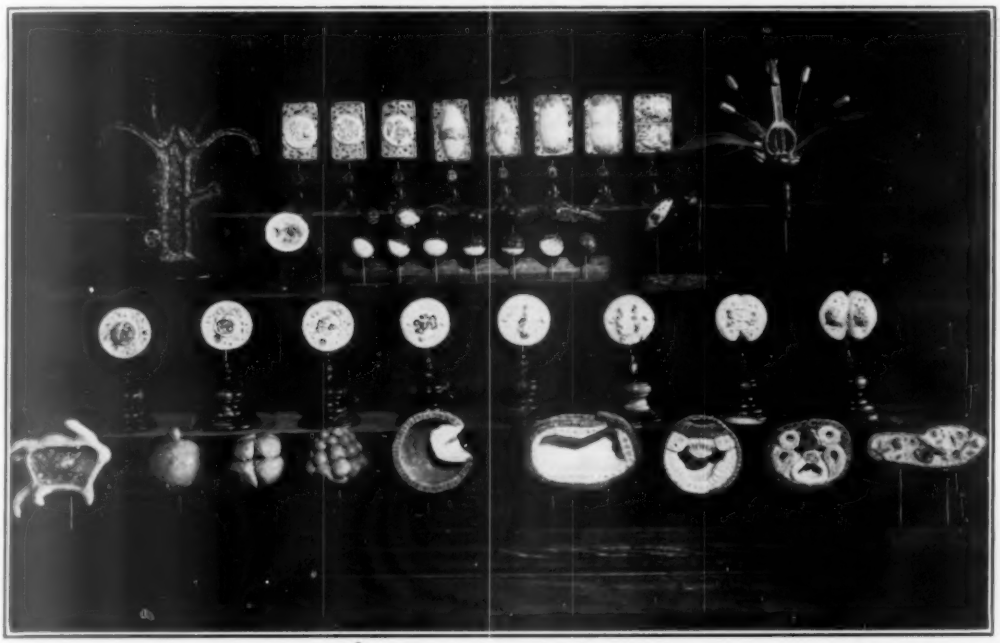
Before the models are dry, pieces of $\frac{1}{8}$ or $\frac{1}{10}$ inch wire, about twelve inches in length, are inserted deeply into the body of the object in such a way that it can later be mounted on a base or stand.

Procedure

The procedure varies according to the shape and size of the model to be made. In modeling a hydra, a cardboard mailing tube about 7 inches in circumference is cut in half (lengthwise). One end is slit down an inch or so and the edges overlapped and wired in place. A semicircular mouth is cut into the overlapped edges. Then 4 or 5 strong wires are attached to the cardboard at the proper level and bent at suggestive angles. These wires form a support for the tentacles. Moulding clay or asbestos is added to this basic structure, a layer inside for the endothelium, and a layer outside for the epithelium. Ovary protuberances and testicular masses are modeled in. Cell walls are indented on the cut surfaces and nuclei enameled in later. A few long horse hairs can be inserted for exploded nematocysts. Further characteristic details of hydra are brought out with brush and enamel, the cardboard edge between the outer and inner layer making excellent mesoglea.

Paramecium and other protozoa are modeled freely. Clay is rolled on a glass plate which has been moistened with glycerine. The roll is cut in half and the flat surface placed down in the glycerine. A half-body is shaped and longitudinal rows of hexagonal areas impressed on the soft surface with a small hexagonal stick (one can be made from a soft pencil). Into the center of each hexagonal area a stiff horse hair cut about one and a half inches long is forced in at an angle of

LABORATORY MODELS



1st Row	Hydra	—Plant Mitosis—	Diagrammatic Flower
2nd Row	Vorticella	—Frog Embryology—	Euglena and Trypanosome
3rd Row		—Animal Mitosis—	
4th Row	Ameba	—Early Embryology of Amphioxus—	Paramecium

about 30 degrees. These cilia[4] should point toward the posterior end of the model which has been made slipper-shaped and smoothed with glycerine previous to the marking. After the model dries 48 or more hours it can be turned over and the face worked in. A hollow gullet ending in a food vacuole, made from a thin layer of clay, can be partially raised above the surface. Nuclei, contractile vacuoles, food balls, and anal apertures are readily modeled.

A realistic finish is obtained by enameling the "animal" in a basic coat of light tan, while pellicle, anus, and some of the cytoplasmic inclusions are painted in deeper shades of tan and brown. The food vacuoles may be painted pink and the contractile vacuoles gray.

Dishes serve as suitable forms for modeling rounded cells or rectangular bodies. The cells demonstrating animal mitosis (illustration) were modeled in a small round oatmeal dish and the plant cells in a rectangular glass butter dish.

Dishes are lubricated with a generous amount of glycerine. Then a layer of clay is put in after the manner of lining a pie tin with dough. The clay is packed tight with excelsior or "Spanish moss" and a layer of clay placed over the filler even with the rim of the dish. The edges are worked together and the whole cell

(Continued on page 195)

[4] Newman, H. H. 1926. *Outlines of General Zoology*, Macmillan, p. 123.

Embryonic Material for Laboratory Experimentation

ROBERTS RUGH
Hunter College and Columbia University

From many High Schools and Colleges have come requests for information regarding the technique for inducing egg-laying among the Amphibia during the academic year, which coincides with the normal period of hibernation for these animals. Qualified students, under appropriate guidance, can now conduct experiments along the lines of artificial parthenogenesis (Parmenter, '25) or can study the effect of hormones or of altered environmental conditions on normal development. Such experiments require but little equipment and the use of such objects as living frog or salamander embryos carries a tremendous stimulus to the beginnings of research interest. The rudiments of research technique can be acquired with real enthusiasm, and spectacular results can be achieved during the course of a single academic year. It is the purpose of this paper to describe the technique, now used, to secure fertilized amphibian eggs in the laboratory within 24 hours at any time during the academic year.

In 1929 two brief papers appeared (Houssay, Giusti & Lascano-Gonzalez and O. M. Wolf), one from Argentina and the other from Wisconsin, describing the effect of the anterior pituitary hormone on the ovaries of toads and frogs. In 1930 (Adams) the same technique was used successfully on salamanders. In 1935 (Rugh) an extended study of the pituitary-ovulation relation was reported and in 1937 (Rugh) the relationship was put on a quantitative basis. The following procedure is used almost daily throughout the academic year at the Laboratory of Experimental Morphology, Columbia University, and is being used in an increasing number of Colleges in connection with their courses in experimental zoology and in embryology.

There is reason to believe that any Amphibian, whether urodele or anura, will respond to the anterior pituitary hormone by ovulation if it is mature and has ovaries that contain mature eggs. Some of the more common forms that have been reported to respond to this hormone are:

Amblystoma tigrinum
Bufo: americanus, arenarum, d'Orbignyi, fowleri, and vulgaris
Desmognathus fuscus
Eurycea bislineata
Gyrinophilus porphyritus
Leptodactyllus ocellatus
Pseudobranchus
Rana: catesbiana, clamitans, palustris, pipiens, sphenocephala, temporaria, and vulgaris
Rhycatriton olympicus
Stereochilus marginatum
Triturus: pyrrhogaster and viridescens
Xenopus laevis

Since hibernating Amphibia are best to use, it is suggested that Rana pipiens be used from September until February; Rana clamitans from February to July; Rana catesbiana through the summer; and either Rana sphenocephala or Acris gryllus from July to October. These

periods precede the normal breeding seasor for each of the forms.

While the urodeles will keep well in the laboratory, and if properly fed, will produce eggs (under pituitary stimulation) throughout the winter, the frogs and toads (except Xenopus) should be fresh-caught while hibernating and used within two weeks. This is because laboratory temperatures and food supply are not appropriate; the animals starve and the ovaries degenerate. Until used, these anura are kept best either in a cold room (12–14° C.) or in the refrigerator (4° C.). Body size is a fair means of determining maturity, and the size ranges of North American Anura are given in the remarkably complete and useful Handbook by A. H. Wright. Rana pipiens, the leopard frog, is the most abundant and most easily procured American frog and the following description will apply particularly to this species. The same methods, however, with only slight modifications, may be used with other forms in the list above.

The body length of mature specimens of Rana pipiens is at least 73 mm. (snout to cloaca) and the best females usually measure 85–95 mm. If the frogs are secured from hibernation[1] and immediately placed in a little water in a cold environment, they can be kept healthy for several weeks. A copper-lined box or a copper pan within the container helps to reduce the probability of infection from red-leg.

Twenty-four to thirty hours before the eggs are desired, an obviously mature female is selected and is injected with from four to eight anterior pituitary glands recently removed from frogs. The pituitary is removed by cutting off the head of the frog 1 cm. posterior to the eyes cutting away the lower jaw; inserting the scissors along the side and beneath the medula so as to cut through the transverse processes of the parasphenoidal bone; deflecting this bone forward and exposing the kidney-shaped, pink, anterior pituitary gland. It is located slightly posterior to the level of the eyes, and is surrounded by white, flocculent endolymphatic tissue (see Proc. Soc. Exp. Biol. & Med. 1939, 40: 132). The gland is immediately placed in a very small amount of water.[2] After enough pituitaries have been accumulated (6–8 female glands in the Fall and 4–6 in early Spring) they are sucked up into the barrel of a hypodermic syringe; a #20 needle is applied and injected through the abdominal wall of the female frog. The soft and pliable glands will easily pass through such a needle into the coelomic cavity of the frog.

It has been found that female pituitaries are relatively about twice as potent as male pituitaries in inducing sexual reactions among the Amphibia, so that if males are used as donors the doses should be doubled. Pituitaries from other Amphibia are effective, but the dose varies with the source and generalizations cannot be made. Fish and mammalian pituitaries have been used with some success,

[1] Those who do not have the information may write the author who will be glad to supply the name and address (and the cost of the frogs) of a man who can supply excellent living animals at any time of the year.

[2] If the pituitaries are not to be used immediately, they may be kept in 100% alcohol for at least a year, if necessary, without loss of potency. Prior to injection, however, this solution must be reduced to at most 35% alcohol. Many pituitaries may be accumulated from physiology or morphology laboratories where they are generally discarded.

more particularly with the urodeles than with the anura. In fact, the human pituitary hormone has been used in such forms as Xenopus where urine from pregnant women will cause ovulation.

Another interesting point has very recently been discovered, namely that if the anterior pituitary gland is removed from the female to be injected, that the dose necessary to induce complete ovulation is very much reduced. In fact, if the pituitary is first removed and then injected into the same female twelve hours later, as many as 50% of the eggs will be released from the ovaries while if the host's pituitary is left intact the same response will require a total of four glands. It has long been known that ovulation among the Amphibia is not an all-or-none reaction, but that the number of eggs leaving the ovary depends in part upon the dose of the anterior pituitary hormone injected. The doses prescribed above should give almost 100% ovulation.

Following the injection the female is kept in enough water to be partially submerged, for normal ovulation involves a certain amount of imbibition. It is best to keep the temperature near 20° C., or lower, for the eggs within the uteri deteriorate quickly at the higher temperatures. However, it must be pointed out that the lower the temperature the longer period will elapse before there is response to the injected hormone.

To secure eggs and subsequently the tadpoles, the general practice has been to inject only the female since there are at all times during hibernation abundant mature spermatozoa within the testes of male frogs, which need only liberation in an appropriate medium for activation. However, it is well to demonstrate amplexus and normal egg-laying, and this can be done by simultaneously injecting a mature male with an equivalent dose of the anterior pituitary hormone. Amplexus, at room temperatures, will be achieved overnight, and eggs will be laid by the pair within twenty-four hours.

It is possible now to secure 100% fertilization by artificially controlling insemination in the laboratory, and as a result appropriate stages of development can be secured at any desired time. In this case the female is kept isolated. A sperm suspension is made by cutting up two or more pairs of testes in 10 cc. of a modification of amphibian Ringer's solution (Holtfreter, 1931), the formula of which is given below:

NaCl	0.35 gr.
KCl	0.005 gr.
$CaCl_2$	0.01 gr.
$NaHCO_3$	0.02 gr.
H_2O	100.00 cc.

This solution should be kept as stock and diluted with 9 parts of distilled water before using for sperm suspensions. In its concentrated form it is excellent for amphibian tissues. After a few minutes (1 minute to 6 hours) eggs may be stripped from the uteri of the ovulating female (into the sperm suspension) by gentle pressure around the body toward the cloaca. As many as 2,000 eggs may be secured from a single female. As the eggs drop into the sperm suspension, the finger bowl should be gently agitated so as to spread the eggs more or less evenly throughout the sperm suspension.

In about 15–30 minutes the egg mass should be flooded with the same water used for the sperm suspension, or with pond water in which Amphibia are known to live. This latter type of water may also be used for the sperm suspen-

sion, particularly if it is difficult to make up the more uniform Holtfreter's solution. Within an hour the eggs will have rotated and taken on their full quota of jelly and should be removed to a much larger container with abundant water. Ultimately the eggs should be cut into clusters of 25–50 and placed in finger bowls full of water. This number per finger bowl will grow quite normally. Development will proceed even at refrigerator temperatures, though slowly, but temperatures should be controlled at about 20–22° C. if possible. At higher temperatures the eggs should be further separated and given abundant water per egg.

Within 2½ to 3 hours at ordinary laboratory temperatures the first cleavage will be evident; within 8 hours the embryos will be blastulae; and within 24 hours they will be gastrulating. Care must be taken to use only such instruments as have never come in contact with any poisonous (killing) fluids; glassware that is thoroughly clean. It must be remembered that the highly pigmented amphibian egg is very receptive to radiant energy and must be kept away from either direct sunlight or prolonged artificial lighting.

The entire ovulation process may be observed if the female is anesthetized and the abdomen is opened within 14–16 hours after pituitary injection. The frog may be opened under Holtfreter's solution, which should be used abundantly to moisten all tissues. If the ventral body wall is cut away the entire ovulation process may be observed with the naked eye. Ovarian contractions will be seen; eggs will drop away from their follicles into the body cavity, to be picked up by the numerous coelomic cilia and carried to the ostia, into these openings, through the oviducts and into the uteri. It takes about four hours at ordinary laboratory temperatures for the eggs to travel from the ostium to the uterus, and the rotation within the oviducts is easily aparent.

There are few observations in Biology more fascinating than the development of an organism from the single egg, particularly when the observations begin with fertilization. It is, of course, necessary first to understand this normal development before experimental conditions are applied. And in every instance sufficient and appropriate controls must be carried, using the same animal material that is used for the experimental conditions. There are still an unlimited number of research problems which can be approached through the use of this accessible animal material.

References

Adams, A. E. 1930—"Some effects of pituitary grafts in adult urodeles (Triturus viridescens)." Proc. 2nd Int. Congress Sex Research 190.

Holtfreter, J. 1931—"Uber die Aufzuchtisolierter teile des amphibienkeimes." Arch. f. Ent. Meck. der Org. 124: 404.

Houssay, B. A., L. Giusti, and J. M. Lascano-Gonzalez. 1929—"Implantacion d'hypophyse et stimulation des glandes des fonctions sexuelles du crapaud." Compt. rend. Soc. de Biol. 102: 864.

Parmenter, C. L. 1925—"The chromosomes of parthenogenetic frogs and tadpoles." Jour. Gen. Physiol. 88: 1.

Rugh, R. 1935—"Ovulation in the frog: I. Pituitary relations in induced ovulations." Jour. Exp. Zool. 71: 149.

Rugh, R. 1937—"A quantitative analysis of the pituitary-ovulation relation in the frog (Rana pipiens)." Physiological Zoology 10: 84.

Wolf, O. M. 1929—"Effect of daily transplants of anterior lobe of the pituitary on reproduction of the frog." Proc. Soc. Exp. Biol. & Med. 26: 692 and Anat. Rec. 44: 206.

PRESIDENTS MESSAGE

As retiring president I wish to thank those that assisted the association over a critical period,—its organization and first year. Mention should certainly be made of the aid from the Committee on Biological Science Teaching, the organization delegates, the executive board, and the hundreds of biology teachers that pledged their support and paid their membership dues prior to organization. This support is indicative of the fact that there was a need for this type of association.

The affiliated locals should be encouraged during the next few years. This is a fertile field and will contribute materially to the parent organization. The formation of additional locals rests with the biology teachers of a given region; but support can come from the national after formation. It will be from the groups of affiliated locals that future leaders of the national will be selected. Attention must also be given to the educational studies being made or started by the local chapters. Such studies can well be the nucleus for the study of biological problems national in their scope.

The journal also commands attention. It is with regret that the next volume of THE AMERICAN BIOLOGY TEACHER will, in all probability, be under the direction of a new editor-in-chief. Mr. Herskowitz has set a high standard—this must be maintained. The journal is the official organ and commands your support.

In conclusion I sincerely hope you give the same cooperation to the new Executive Board as you did the first. We cannot all be officers, nor write dynamic articles for publication. However we all can help the National Association of Biology Teachers materially with our membership dues and aid in securing new members.

M. C. LICHTENWALTER

OUR NEW OFFICERS
1939-1940

At the December meeting the executive board of The National Association of Biology Teachers appointed a nominating committee for the purpose of making nominations for the offices of president-elect, first vice-president, second vice-president, and secretary-treasurer in conformance with the regulations prescribed by the constitution of the association. Dr. D. F. Miller was appointed chairman of the nominating committee. Ballots were mailed during February to all paid up members and returned votes were counted after April 15th. The results of that election are as follows:

President-elect: George W. Jeffers, State Teachers College, Farmville, Virginia.

First Vice-president: Miss Villa B. Smith, John Hay High School, Cleveland, Ohio.

Second Vice-president: Charles C. Herbst, Beverly Hills High School, Beverly Hills, California.

Secretary-treasurer: P. K. Houdek, Township High School, Robinson, Illinois.

Our new officers take over their duties on July 1, 1939, and will remain in office for one year.

In addition our president-elect for the present year, Malcolm D. Campbell, Dorchester High School for Boys, Dorchester, Massachusetts, will become president for the coming year.

Our sincerest congratulations to our new officers.

Exchange Service

Frank Shaw, Junior College, Can Luis Obispo, California, will exchange marine animal forms and representative local botanical specimens for biological materials from other parts of the country.

NEW ENGLAND BIOLOGICAL ASSOCIATION ACTIVE

Members of the New England Biological Association gathered for the third regular meeting of the association during this school year at the New England Museum of Natural History. As usual attendance was impressive; approximately 125 teachers coming from Massachusetts and more distant states, to attend the meeting and participate in the discussions meeting and participate in the discussions.

The meeting opened with Leo J. Fitzpatrick, president of the association, presiding. Following introductory remarks by President Fitzpatrick, Dr. Edward Wigglesworth, Scientific Director, New England Museum of Natural History, gave an address of welcome to the association. Following a brief business meeting in which the treasurer reported a very satisfactory payment of dues both to the local and national associations, Miss Eunice Sharp, of the faculty of Chicopee High School, Chicopee, Mass., gave a teaching demonstration of vertebrate skeletons, which was well received. The next speaker was Dr. C. W. Pomerat, Clark University, Worcester, Mass. Dr. Pomerat spoke of the value of blackboard drawing by the biology teacher and illustrated his subject with unusual facility.

Following luncheon, Mr. E. S. Russell, provided a demonstration of biological apparatus and material which proved of practical help to all. Next on the program was Dr. Kenneth S. Rice, Dept. of Education, New England Museum of Natural History, who spoke on the subject, "The Use of a Museum of Natural History by Science Teachers."

LEO J. FITZPATRICK

ROUND TABLE INTENSIFIES ACTIVITIES

The March twenty-fourth meeting of the Chicago Biology Round Table was exceptionally well attended. Last minute reservations necessitated the addition of a number of extra dinner covers to accommodate the members. Dr. L. H. Tiffany, professor of botany at Northwestern University, was the principal speaker of the evening.

The illustrated address by Dr. Tiffany was on the algae and proved to be extremely interesting. Many unusual highlights concerning this simple group of plant life were presented. Contrary to general opinion there are several more groups of algae than the currently common four color groups. Certain species live in extremes of temperature, some in ice, others in water of geyser streams up to eighty-seven degrees Centigrade; others thrive in unusual extremes of pH values of acidity or alkalinity. One peculiar species is found only on the backs of turtles.

Indications are in evidence that the earliest fossiliferous stratas point to the presence of algae with other first life forms. Specific species of algae lead seasonal existences generally connecting a period of dormancy with an active period, however, all species do not conform to the same seasonal period; one can expect to find some few types available at any season in favorable growing areas.

Miss Thelma Jones of Bowen High School reported on the progress being made by the committee working on the Council of High School Biology Clubs.

M. C. LICHTENWALTER

THE KANSAS ASSOCIATION OF BIOLOGY TEACHERS

The Executive Committee and several members of the Kansas Association of Biology Teachers had a meeting in Lawrence, Kansas, on April 1, 1939, in conjunction with the Kansas Academy of Science. The meeting commemorated the first anniversary of the organization of the Kansas Unit of the National Association of Biology Teachers. In a business session, it was decided to begin studies on some problems of especial interest to biology teachers in Kansas. Committees were appointed to begin work on (1) the subject matter content of biology courses, and (2) methods in use in the teaching of the biology course in the high schools, with the possible improvement of both in view. These committees are to report at the next state meeting, which will be in Topeka in November.

NORTHERN INDIANA ASSOCIATION

In spite of rain and snow during practically the entire day, a splendid meeting was held by the Northern Indiana Association of Biology Teachers on April 15. A very enthusiastic group of teachers met at the Wabash High School, Wabash, Indiana, and enjoyed the following program:

1. Opportunities for Field Work
   Paul F. Watson, Rochester
2. Field Study of Birds
   Terzo P. Amidei, E. Chicago
3. Collecting Materials for Class Room Study
   Oscar Valentine, Knox
4. Study of Tree Flowers in Spring
   Miss Vesta Thompson, Fort Wayne

During a lull in the storm, the group took to the field nearby and enjoyed a very good demonstration field trip at which time many of the teachers collected specimens to take to their schools. All enjoyed the leadership and training in field trip methods.

A PHILOSOPHY FOR THE BIOLOGY TEACHER

Life, as viewed by modern biologists, is a process of continuous interaction between the living organism and the environment. The most successful living proceeds through the conscious effort of man as he reflects and deliberates about all that is purposeful to the good life.

Education as a process serves as the guide to the individual in his search for meaningful living. Thinking, perceiving and learning are all phases of this educating, which in itself is an enrichment of society.

Dynamic processes of growth, bring together the activities of life and education into an analogous fact. "Education Is Life," appears more meaningful as we consider the deep association between these processes.

We as teachers of biology have the vital task of presenting the very essence of both life and education. Realizing the momentous problems involving living, our aim should be to develop worth-while responses in the student through our medium of biology teaching. The fascinating study of life can be an everlasting influence of good on those we teach. Likewise as educators and biologists we will grow and develop through our bound association with life.

Raymond Lynch,
Loyola University

Biological Briefs

RUTH SHERMAN

WRIGHT, WILLARD H. *Studies on Trichinosis.* XI. The Epidemiology of *Trichinella Spiralis.* American Journal of Public Health 29: 119–127. February, 1939.

This article reports the results of a study made to determine the incidence of trichinosis throughout the United States. The average incidence is between 16 and 18%. There was apparently no correlation between the extent of infestation and the types of population groups studied, except that where Mosaic laws prohibiting the eating of pork were strictly observed, the parasite was rare. Infestation was found to be heaviest along the North Atlantic seaboard and the Pacific coast, in regions where swine are fed mainly on uncooked garbage. At present, methods aiming towards control of the disease include a campaign to warn the public to cook pork well, and federal regulations requiring extended refrigeration or curing of all pork customarily eaten without cooking. Both methods are of considerable value, but the author suggests that regulations requiring that all garbage be cooked before use as food for swine would effectively reduce the rate of incidence of this parasite.

GRINNELL, JOSEPH. *Effects of a Wet Year on Mammalian Populations.* Journal of Mammalogy 20: 62–64. February, 1939.

After an unusually wet winter, Dr. Grinnell surveyed the mammalian and bird population in northeastern California, where large areas of flat land had been flooded. Rabbits were scarce. Oregon ground squirrels, which hibernate in underground burrows, were far less abundant than usual, although the sub-species which nests in sloping terrain was not so badly affected as that which burrows in low, flat ground. The burrowers met death not only by drowning, but probably also through exposure when they could find no dry habitations. Thus for such south-western rodents, the flood factor may be important in establishing geographic races and likewise in the fluctuation of population numbers.

PRIOR, SOPHIA. *Carnivorous Plants and "The Man-Eating Tree."* Field Museum of Natural History Botanical Leaflet 23. 1939.

The leaflet presents descriptions and illustrations (drawings and photographs) of a number of carnivorous plants, including bladderworts, sun-dew, Venus's fly trap, and pitcher plants. In addition, the author quotes verbatim startling Sunday-supplement descriptions of such mythical floral wonders as the death flower, the snake-tree, the flesh-eating vine, and the man-eating tree, with the remark that as exploration continues to make known more and more African and South American territory, the habitat of these plants must continually be shifted to the furthermost inaccessible regions.

Biology Teaching Aids

TEACHING AIDS IN BIOLOGY

The enterprising teacher will develop many teaching aids from the local environment which will be more or less adapted to his particular teaching situation. Teaching aids must be considered in the light of their adaptability to local teaching needs, the learning needs of the pupils, the financial ability of the school system to purchase these aids, and the local resources, such as electricity, gas, suitable rooms and funds for the operation of such equipment. The so-called "visual aids," like the microscope, stereopticon, opaque projector, micro-projector, stereoscope, films, graphs, charts, and general equipment of the laboratory, are necessary adjuncts in order to help for better learning situations and for better teaching.

Teaching aids help to stimulate the interests of the pupils, help the students form correct concepts, develop their powers of observation, extend their powers of vision, economize their time and energy in learning, stimulate and cultivate the imagination and above all, develop an appreciation of the culture of the past by inculcating a different perspective of the things they observe through the scientific method.

Teaching aids can be listed as follows:

1. Visual Aids:

a. Micro-projector
b. Stereograph
c. Stereoscope
d. Stereopticon
e. Opaque projector
f. Field Trips
g. Models
h. Biology Clubs
i. Projects
j. Graphs
k. Pictures
l. Charts
m. Lantern Slides
n. Bulletins
o. Pamphlets
p. Aquaria
q. Terraria
r. Museums
s. Microscopes
t. Microphotographs
u. Motion Picture Films
v. Experiments
w. Demonstrations
x. Text Books
y. Class Newspaper
z. Library
aa. Book Reports
bb. Book Reviews

2. Pedagogical Aids:

a. Scientific Method
b. Problem Method
c. Project Method
d. Dalton "Contract" Plan
e. Lecture Method
f. Demonstration Method
g. Inductive-Deductive Method
h. Socialized Recitation

All teachers should learn how to use their aids so as to benefit their pupils to the fullest extent. All teachers should therefore learn how to modify their present equipment to meet their needs and those of the pupils they teach.

This column has been projected as a clearing house for teachers to send articles, telling others what they are doing to simplify, revive and renovate these teaching aids, "visual aids," techniques and demonstrations for their own use in their respective localities.

Please send all contributions, questions and answers to

MARCUS LILLING,
Seward Park High School,
350 Grand St., New York City.

THE VIVARIUM

Vivaria are a necessary adjunct to every biology laboratory. For the past

year one in particular in my laboratory has created an unusual amount of interest among my students and several of the faculty members have passed favorable comments on it. These plants do attract attention for many individuals have never seen them for they do not go to conservatories or supply houses where such plants are grown.

For a very small sum a vivarium can be purchased or an old aquarium might be substituted. Two inches of humus is placed in the bottom, built up slightly in back; in this the small plants are planted. In our vivarium we have woodland ferns, table ferns, creeping snow berry, moss, club mosses, liverworts, and sedum. The very prolific growth of these plants give the appearance of the floor of the woods with their denseness and greenness.

The care of this type of equipment is appreciably negligible. This year our vivarium has been watered just twice. No fungus has appeared thus far. One is warned to watch for fungus growth and remove it as soon as it appears.

Such equipment can be most helpful in biology. In the study of the life histories of ferns and mosses the leafy fern sporophyte, the leafy moss gametophyte, and the leafless moss sporophyte with the sporangium can be pointed out and observed. The real plant makes this work much clearer to the student than by just using charts to explain these structures. Then, too, the various types can be understood and remembered much easier when a student has seen them as well as studied about them. Transpiration of plants is no longer doubted for the sides of the vivarium give evidence of it daily.

HELEN TROWBRIDGE,
Glenbard Township High School,
Glen Ellyn, Illinois.

CULTURING INVERTEBRATES

AQUATIC SNAILS (*Gastropoda*)

Aquatic snails may be found in most streams, permanent ponds, and lakes. They are usually found on either living or decaying plants.

Small jars (glass) are best for keeping snails. Three to five in a bottle. The water must be changed daily.

Lettuce or bits of decaying leaves may be used as food. Care should be taken to not allow the food to become sour.

Some aquatic snails will do very well in a balanced aquarium.

CENTIPEDS (*Chilopoda*)—SOW BUGS (*Cylisticus convexus*) LAND SNAILS (*Gastropoda*)—SLUGS (*Gastropoda*)

These animals are usually found in cool, moist places, especially under dead leaves, boards, stones, etc.

While bringing the animals into the laboratory, much care should be taken to keep them moist, since drying will kill them quickly.

It has been found that a shallow glass dish $2\frac{1}{2}''$ deep is most satisfactory for keeping the animals. Place the animals in dishes half filled with moist soil, or preferably moist peat, and cover with plate glass. Peat is better than soil, since it does not sour as quickly as the latter.

Decayed leaves, bits of apple or bananas, or lettuce proved to be satisfactory food materials.

Bark or small bits of wood placed on the top of the soil or peat will serve as hiding places.

Crayfish (*Decapoda*)

Crayfish from ponds or lakes thrive best in the laboratory. They may be kept well in shallow jars which contain one or one-and-one-half inches of water.

They will eat chopped beef, bits of apple, and lettuce, but seem to prefer apple seeds, which they eat very readily.

Grasshopper (*Insecta—Ortheoptera*)

Collect in open fields in late summer or fall before the frost comes. Do not place in containers with crickets as the latter will soon kill and devour them.

In the laboratory place in a box container which has screening on the sides and a bottom suitable for holding soil. The soil will also aid to keep the container dry. The container should be placed in a position where a little sunshine will strike it.

Grass, seedlings or lettuce are good food materials. A dish of water is also necessary.

Mating occurs very often and may be observed.

Leeches (*Hirudineae*)

Leeches of many species may be collected and kept in the laboratory for a considerable time. They may be used as food for fish or for experimental laboratory animals.

Leeches are found between leaves of water plants such as cattails, often at the water line, sometimes at the base under stones. Many times they are found on leaves which have sunk to the bottom. Turtles provide a very good host for these forms. Occasionally frogs are found which have leeches attached to them.

Fresh, bloody meat may be used as bait for catching leeches. Attach a string or wire to the meat and leave in the marshy area of a stream, lake, or permanent pond for a few hours or over night.

Four of five leeches placed in a pint food jar, three-fourths filled with water, will live for a considerable length of time. A *small* amount of grass may be added to the water. Most leeches will thrive well on Tubifex, and also earthworms, which have been chopped fine.

Fresh-water Mussels (*Sphaerium*)

Prepare a bowl for these animals by putting in a small amount of sand and filling it half-full of water. If water which is known to contain Protozoa can be obtained, it should be used, since the food of these animals consists of protozoans and bacteria. However, if such water cannot be obtained, a protozoan culture should be started and used to feed the Sphaerium.

These animals may be placed in an aquarium where they can be observed half buried in the sand.

Water Scorpion (*Nepidae*)
Back Swimmer (*Notonectidae*)

Many of these insects are found in the plants along the sides and the bottom of slow moving streams and ponds.

Place the insects in half-pint food jars, half filled with pond water, containing a small amount of growing plants—Elodea or Netella. Cover the jars with a fine mesh screen.

The water should be changed once a

week and fresh pond or aquarium water added.

Tubifex or small earthworms chopped fine should be fed daily. Small minnows or insects can be used as food also.

Earthworm (*Annelida*)

Earthworms may be found in moist humus.

These may be kept for long periods of time, if kept in suitable containers such as one-gallon tin cans which may be obtained from most any restaurant. Holes should be punched in the bottom of the cans with *tacks*, not nails, since the worms will escape if the holes are too large.

The soil in the bottom of the can should be kept moist, but not wet since the soil will quickly sour. The holes in the bottom will aid in taking care of excess moisture.

Place dead leaves or coffee grounds on the top of the soil occasionally.

Glass jars will not work well.

Michigan University

(Continued from page 183)

turned onto a glass plate covered with glycerine. Cross walls must be built into the cells illustrating late anaphase and telophase. After drying for several days the set can be turned over and the faces completed.

A filler does not have to be used in making the cells but it makes the finished product much lighter than solid clay or pure asbestos. A filler is particularly desirable when large cells, such as are seen in the Amphioxus set (illustration), are modeled.

Fine wire, the kind that is used in making paper flowers, can be inserted on the face in spindle-form as spindle fibers. Spireme threads and forming chromosomes are made of cord or fine beads strung on wire. These can be prepared while the backs of the cells are hardening, and will be ready to insert when the faces are designed.

Many common objects can be used as modeling material. Small spongy rubber balls (2 for $0.05) form the base for most of the models, representing the early embryological development of the frog (illustration). They were mounted on wires, covered with clay, grooved, and painted. A small hollow rubber ball was halved and used as a base for the blastula.

Undulating membranes for trypanosomes can be cut from celluloid and the stuffed enameled fingers of a soft rubber glove form excellent pseudopodia for an arcella, the shell of which is modeled in a small deep saucer.

There are many tricks to the trade, it seems, but when all is said and done, modeling is easy. The resourceful and persevering student, besides learning much that is already known, will make discoveries. He will find new methods, new materials, new modes of expression well worth recording. He will develop a fruitful interest in science.

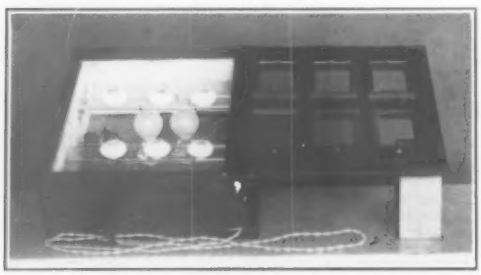
These few suggestions may serve as a stimulus to the beginner. Instructors might advise students to start modeling something in which they are interested and which they can make. After a modeling project is undertaken, the teacher should not permit the student to stop until the model has been completed, for it is the mounting and the enameling and the last clever finishing stroke that bring satisfaction and success.

An Incubator for the Study of Living Embryos

S. EDMUND STODDARD
High School, Blackfoot, Idaho

In the perusal of biological science at the Blackfoot High School the study of developmental processes has been given a prominent position. Surely in life science the study of the development of life is important. To aid these studies an incubator was constructed that may be of interest to other biology teachers.

A box was constructed having a length of 18 inches, a width of 18 inches, and a height of 8 inches. The box was lined with wood fiber for the conservation of heat. In the lid are six glass windows, each being 4 x 3 inches. The glass over each window can be removed separately for the insertion of eggs without necessitation of the removal of the larger lid. Figure I shows the finished incubator with lid removed. The wafer-type thermostat can be clearly seen. Two 60 watt Mazda bulbs are used as a source of heat. The eggs are placed on wire supports and kept in place by two glass rods.



INCUBATOR

FIG. I. Photograph of an incubator used in the study of living embryos. A section of the shell is removed, a cover glass is cemented over the opening, and the egg is placed under one of the glass windows.

Each day for six consecutive days a section of the shell of a hen egg was removed and the egg placed beneath a window. After a section of the shell was removed several methods were employed in the construction of a miniature window. One method was the cementing of a piece of sterilized white cellophane in place of the shell. A second procedure was the cementing of a three-fourths' inch cover glass over the opening. Collodion was used to adhere the glass to the shell. Small amounts of cotton were inserted in openings between the shell and the glass. The cotton was then covered with a layer of collodion. A third method was the use of adhesive tape to fasten the cover glass to the shell.

By use of this incubator one will have at the end of six days a demonstration of growing embryos for use in class demonstrations.

LANTERN SLIDES

Doubtless a large number of teachers have been making their lantern slides for years but how many have ever tried to teach students to make those particularly suited to the needs of the course and the locality? Even in the large schools

where money is available for the purchase and filing of slides it may not always be possible to find those that exactly suit the immediate needs.

For this reason students started project work on a series of lantern slides. Only four microscopes were available for classes of thirty or more students and no microprojector was at hand. Consequently it was difficult to show students the actual materials. Careful drawings were made of living and preserved specimens and from microscopic slides, several students working on each topic. The best drawing in each case was selected and used in making the lantern slides. Glass plates of regulation size were coated with the prepared material, a kind of albumen needed to make the drawings adhere to the glass. Then under a magnifier India ink was applied either with small brushes or drawing pens to the outline which had been traced on with a blunt needle. Some students taking art were able to sketch and color drawings of habitats, various stages in the life of ancient man and to make some original settings to show the development of the camel and the horse. Some students sketched museum specimens of odd shapes and queer forms to show various attempts of nature in producing higher forms. One was very clever in sketching portraits of famous scientists and making scenes depicting their lives.

When the sketches were made, two glass plates were fastened together with the drawing between. After binding them together with passe partout or any commercial binding and affixing the labels in the proper corners to aid in showing them, the slides were numbered and cataloged. A brief description of each slide was prepared and also placed in the proper file. When all slides on one unit or topic were completed an illustrated lecture was prepared and after one or more practice periods outside of school hours those students most interested and competent presented the lecture to the whole class.

In this manner it was possible to build permanent equipment on any topic desired. When a slide was no longer useful or a better one was produced it was very simple to separate the glass plates by soaking in water and then dissolving the albumen by heating the water. Thus the glass could be used again. When it was not possible to buy glass plates they were cut from ordinary glass but they were not quite so clear.

Sometimes, because of lack of other material, the students project drawings from microscopic slides on the light colored walls of the classroom, on the daylight screen or on the white curtain screen and use those for their own drawings. Students work individually on topics and units. Material is always available and many different forms may be studied in the same laboratory period. One requirement, however, is essential—that the student see and study the original slide or specimen in so far as possible before he makes use of any drawing aid.

RUTH A. DODGE
Johnstown High School
Johnstown, N. Y.

Living Cocoons;—15 for $1.00 including Luna & o, **Tropical butterflies,** India or S. America 15 for $1.00, many showey butterflies from 6¢ each, Riker mounts, Entomological Supplies, List Free.

Butterfly World Supply House,
297 East 98th Street, Brooklyn, N. Y.

HINTS FOR STUDENT HIGH SCHOOL BIOLOGY CLUBS

A scholarship of one hundred dollars each year is what one biology club furnishes a deserving member. The Biology Club of Morgan Park High School in Chicago is the club that does this particular piece of work. They raise the money potted plants, cut flowers, and many other similar activities. Much of the growing material is produced in their growing room.

The Beaver Club of Huchins Intermediate School of Detroit maintains a formal garden. This garden is located on a plot of ground on the school campus furnished by the board of education and fenced for the purpose. Each year the club adds a few new shrubs, trees and plants obtained through club finances. The plants are generally the uncommon or the unusual. Money is raised by presenting a yearly vaudeville of student talent.

One biology club is active in making casts of laboratory material. They search through catalogues of biological supply houses for ideas. A particular cast pictured may be duplicated, it may be modified or it might furnish an idea for an entirely different piece of work. Many students become authorities on a particular subject through this activity. The casts are painted and border upon professionalism.

The Bird Club of Bowen High School, Chicago, felt the need of a bird sanctuary for their community. The members drew up a petition and secured thousands of signatures. The formal petition was presented to the park authorities. Since this activity they have had a very popular place to study birds. The park authorities were glad to comply with such a worthy request when backed by such a large petition.

A common practice in a number of clubs is to "start" bulbs at school. They are timed to bloom just before a holiday if possible. They are taken home to their parents perhaps as a pleasant surprise to them.

Painting of flowers by the artistic minded club member becomes an interesting display in a number of instances, after a few months effort.

Does your local biology teachers organization sponsor an annual club exhibit, fair or congress? Do they give the officers of the clubs an opportunity to get together or do the teachers that sponsor the clubs get together and pass the ideas along? Could your local biology teachers organization sponsor joint membership meetings of the biology clubs furnishing them with appropriate programs?

An interesting activity is to furnish a nearby hospital with at least one plant for their poorer ward. Perhaps an aquarium might be permitted in the solarium by the hospital officials.

Chicago has lilac day in the spring. All institutions are flooded with lilacs. Newspapers, womens clubs, and school children help with this service—either furnishing or distributing them.

BOOKS

BIOLOGY TEXTBOOK REVIEWS

In the April issue of THE AMERICAN BIOLOGY TEACHER we discussed the approach to the problem of biology textbook evaluation. We noted the division of reviews into five sections. This analysis is based on the textbook evaluation suggested by George W. Hunter, in *Science Teaching*. It is believed to represent the pooled opinion of many competent persons in the field of biology text evaluation.

Many publishers have aready forwarded copies of their published texts for our review. The following books are available for immediate distribution and review according to the plan outlined in the April issue of THE AMERICAN BIOLOGY TEACHER.

1. High School Biology—Knox, Benedict and Stone.
2. New Introduction of Biology—Kinsey.
3. Everyday Problems in Biology—Pieper, Beauchamp and Frank.
4. Advanced Biology—Wheat and Fitzpatrick.
5. General Biology—Wheat and Fitzpatrick.
6. Dynamic Biology — Baker and Mills.
7. Biology—Moon and Mann.
8. Adventures with Living Things—Kroeber and Wolff.
9. Problems in Biology—Hunter.
10. A Biology of Familiar Things—Bush, Dickie, Runkle.

We again urge all secondary school teachers of biology who are interested send their names to the chairman of the committee with a brief statement of the elements of textbook evaluation to which they would like to be assigned. We would like to have available at least one hundred names of members interested in this work. We suggest communication without delay with the chairman of the reviewing committee.

ALAN A. NATHANS
Christopher Columbus High School,
Astor and Waring Avenues,
Bronx, New York.

COMPTON, R. AND NETTELS, C. H. *Conquests of Science.* New York, Harcourt, Brace and Company, 1939. 378 p. $1.20.

Because of our rapidly growing body of scientific knowledge there is great danger that in our science teaching we may uproot this knowledge completely from the background of feeling and experience from which it has sprung. In so doing, pupils may lose some of the educational values such as appreciations, social sensitivity, and attitudes which by many educators are considered just as important as the facts and principles of science. The story of science is a thrilling account of the efforts of men and women who have labored that all of us might know more about ourselves and the world in which we live.

It is heartening then to find a book such as this. It contains twenty-two selections from the writings of people like Wm. Beebe, John Muir, Eve Curie, Paul De Kruif, Victor Heiser, Roy Chapman Andrews and others. The book pulses with romance, adventure and the thrill of scientific discovery. It should prove

an excellent stimulus for more extensive reading of the popular literature of science by pupils in junior and senior high schools.

The twenty-two selections appear to have been carefully selected. They are non-technical and they cover a wide range of interest. Eight of them deal with plants and animals, six with the physical world, three with health and six with laboratory experiments. They seem to the reviewer to be within the range of comprehension of average ninth grade pupils.

ELWOOD D. HEISS

DAVIS, WATSON, Editor. *The Advance of Science.* New York: Doubleday, Doran & Company, Inc. 1934. 400 pp.

Slow as scientific progress seems at times, it is possible to see year by year an increase in our knowledge of mankind.

It is the purpose of this book to outline the extent to which that knowledge has now advanced in each of the major fields of scientific endeavor. A bird's-eye view of the frontiers reached by man, a view wherein man sees each part of the advance of science in relation to every other part, may fulfill a useful purpose in a world of much confusion.

The book does not pretend to be exhaustive, nor does it pretend to fulfill the needs of the specialist. It is for the layman who is interested in the latest scientific achievements and who wants to be told in his own terms just what has been accomplished.

Science has been hailed both as the savior of mankind and as the monster that is about to devour him. Its implications cannot be ignored whether man fosters or fears it. The limits of human knowledge are expanding daily toward a newer life which is and will be just as different from ours as ours is from yesterday's. What lies beyond is not certain. It is for us to study these facts and to weigh the consequences.

Is the world shrivelling up beneath our feet? How cold is "Absolutely without Heat?" Is there an undiscovered planet? Are stratosphere flights anything more than interesting stunts? Will the use of gas in the next war destroy humanity? Will insects conquer man? Why isn't television here? Will the split atom throw everyone out of work? Has a cure for dread cancer been found? How old is man? These and many other questions are here answered interestingly and clearly.

LEWIS R. HASTIE

BIOLOGICAL ABSTRACTS AND THE SECONDARY SCHOOLS

During the last decade we have seen the world at large and the United States in particular grow increasingly "science conscious." This gradual and subtle change has become a part of everyday life and thought. Even yet, however, science does not attain the position of prominence merited by its great importance to civilization today. And this situation remains in spite of the increased science consciousness together with better and more accurate reporting by the newspapers and periodicals of today. Certain agencies, as Science Service, have provided effective, accurate and popular accounts of the important developments in many of the fields of science. It is to be hoped that these and other agencies as *Biological Abstracts*, will operate, as Barss and Rand* so aptly expressed it,

* H. P. Barss and Frederick V. Rand. *Biological Abstracts and Science Teaching.* School and Society 48: 182–183. August 6, 1938.

"to inspire in the oncoming generation a saner attitude toward policies that are soundly in the interest of human welfare, and to insure a more energetic participation in the social, economic and political activities necessary to carry them into effect."

Biological Abstracts was founded in 1926 and was published for eleven years largely through the support of a generous foundation. Beginning with Volume 12 the journal was placed upon an entirely self supporting basis. Publication during 1938 was possible chiefly through the willing cooperation of the college and university educational institutions that subsidized the journal. Beginning with 1939 the subsidy was abandoned and the subscription price to the complete volume and index was reduced to $25. It was also decided to split Biological Abstracts up into sections as follows:

Section A—*Abstracts of General Biology* to include General Biology, Biography-History, Bibliography, Evolution, Cytology, Genetics, Biometry, and Ecology; price $4.

Section B—*Abstracts of Experimental Animal Biology* to include Animal Physiology, Ecology, Nutrition, Pharmacology, Pathology, Anatomy, Physical Anthropology, Embryology, and Animal Production; $9.

Section C—*Abstracts of Microbiology and Parasitology* to include Immunology, Bacteriology, Viruses, Parasitology, Protozoology, and Helminthology; $5.

Section D—*Abstracts of Plant Sciences* to include Phytopathology, Plant Physiology, Ecology, Plant Anatomy, Paleobotany, Systematic Botany, Agronomy, Horticulture, Forestry, Pharmacognosy and Pharmaceutical Botany; $6.

Section E—*Abstracts of Animal Sciences* to include Paleozoology, Parasitology, Protozoology, Helminthology, Systematic Zoology, Ecology, and Economic Entomology; $6.**

This is mentioned because it is believed that many of the members of the National Association of Biological Teachers are not familiar with the opportunities offered biologists in this abstracting service. Such a service is of particular interest when it is realized how intimate is the relationship of biology to humanity and to a study of the forces of nature and their effects.

Biological Abstracts may of course be utilized in a number of different ways. It may be the means of helping keep the teacher abreast of his particular field by bringing him prompt notice and a digest of research and other publications. Also, the teaching biologist may elect to use it as the source of brief reports dealing with "current events in the program of biological research. Barss and Rand* made this point very effectively when they wrote:

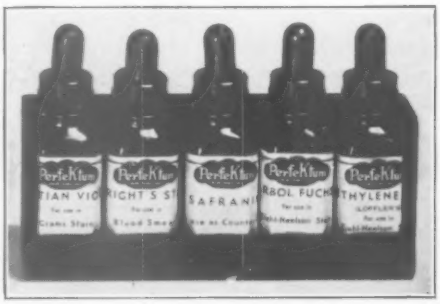
"Covering the wide scope that it does, including all branches of the life sciences and their applications to such fields as human health and disease, vitamins, plant breeding, forestry, horticulture, agronomy, plant and animal physiology, nutrition and pathology, entomology, bacteriology and parasitology, *Biological Abstracts* would appear to lend itself more effectively for this type of educational method than any other available publication within the reach of school libraries."

It is hoped that the above discussion may be useful in pointing out what is believed to be a comparatively new aid to the teaching biologist and one that will prove to be increasingly useful in the years that lie ahead.

George W. Hunter, III
Wesleyan University, Middletown, Conn.

** *Biological Abstracts*—Editorial and Business Office, University of Pennsylvania, Philadelphia, Pa.

PerfeKtum
Stain Packets



General Stains
Carbol Fuchsin — Safranin
Wright's Stain — Gentian Violet
Methylene Blue—Loeffler's

In square 1 oz. dropper bottles and steel rack, conveniently grouped in seven combinations. $2.00 ea.

A complete line of Biological Reagents, Microscope Slides and Coverglasses is available.

Write for information and literature to

PerfeKtum Products Co.,
300 Fourth Ave., N. Y.

"This book makes sense" was one pupil's opinion of

KROEBER & WOLFF'S

Adventures with Living Things

A GENERAL BIOLOGY

Pupil's interest held throughout. . . . Each idea developed simply but completely. . . . Simple language—many attractive illustrations. . . . Scientific thinking encouraged. . . . Interesting exercises, problems, and activities.

D. C. HEATH AND CO.
Boston New York Chicago Atlanta
San Francisco Dallas London

HEGNER, ROBERT. *Big Fleas Have Little Fleas.* Baltimore: Williams and Wilkins Co., 1938.

Prof. Robert Hegner is a well known biologist from his many college textbooks in zoology and the many scientific articles he has written on parasitic protozoans. In the above book Prof. Hegner has exemplified a spirit of a true scientist. He has impressed the reader with his profound knowledge of the subject and the importance of getting the facts before the layman. His fine sense of wit and humor in the many interesting sketches and poetry makes possible the presentation of this scientific book in a captivating manner. The language used is clear and simple avoiding unnecessary scientific terms. For the first time many will be amazed at the broad field in the protozoa world and its many problems that are so definitely related to our daily lives.

Personally I recommend the reading of this book to every teacher in the biological field. One's insight into life will certainly be broadened by it. As a reference book for advanced Biology classes and teachers it will prove a real value. It seems just a little difficult for first year High School students.

F. H. SHAFFER

SOUTHERN BIOLOGICAL SUPPLY CO., Inc.
517 DECATUR ST.
NEW ORLEANS, LA.
CATALOGS ON REQUEST

INDEX TO VOLUME I OF THE AMERICAN BIOLOGY TEACHER

Compiled by PHILIP GOLDSTEIN
Walton High School, New York City

PAGE

BACTERIOLOGY
Suggestions for Laboratory Work in ——. C. M. Hilliard ... 134

BIOLOGICAL BRIEFS
(Abstracts from the literature.) Ruth Sherman ... 126, 158

BIOLOGICAL STATION
Work of the Mountain Lake ——. Ivey F. Lewis ... 109

BIOLOGY TEACHER ASSOCIATIONS
Reports from Local. ——. 13, 41, 58, 137, 192
National Association of Biology Teachers
Constitution of the —— ... 4
President's Message. M. C. Lichtenwalter ... 12
Biology Teachers Begin to Pull Together. O. Riddle ... 1
Vivo Ex Vivo (Editorial). I. A. Herskowitz ... 12
The First Annual Association Meeting, Richmond, Virginia. M. C. Lichtenwalter ... 37
The Richmond Meeting of the ——. M. C. Lichtenwalter ... 57
Our Next Step (Editorial). I. A. Herskowitz ... 76
The Opportunity and Obligation of the ——. O. Riddle ... 116
Local Affiliates *vs.* The National (Editorial). M. C. Lichtenwalter ... 128

BIOLOGY TEACHING AIDS
Anatomy—"Visualization of the Vertebrate Skeleton in the Entire Specimen by Clearing and Selective Staining." Alden B. Dawson ... 91
Bulbs for the Laboratory ... 8
Charts ... 9
Circulation, The —— of Blood ... 8
Classification—"In the Laboratory." Philip E. Foss ... 101
Drawing Aid ... 8
Equipment—"Ground Squirrels as Laboratory Pets." Douglas Salisbury ... 102
Inexpensive Cages ... 8
"An Omnarium." Prevo L. Whitaker 79
A Seine for Small Animals ... 8
Storage Cans ... 8
Fossil Mounts ... 8
Gelatin Mounting ... 9
Insects—"A Nest of Hornets for Your Laboratory." P. K. Houdek ... 40
Moss, To Demonstrate —— Plants ... 8
Photosynthesis, To Prove That Oxygen Is Liberated during ——. Eva B. Ammidon ... 39
Reproduction—"Tropical Fishes in the Classroom." Ruth Sherman ... 129
Soap Modeling ... 9
Soil, Potting —— ... 8
X-Ray Pictures ... 9

BIOLOGY TEACHING—CURRICULUM
Bacteriology—"Suggestions for Laboratory Work in —— for High School Students." C. M. Hilliard ... 134
Biology—"—— As an Upper Grade Subject." L. C. Frost ... 160
"Functional ——." C. C. Crawford ... 93
"Let's Get Together" (Editorial). P. E. Foss ... 56

BIOLOGY TEACHING—EQUIPMENT
The Modern Biology Laboratory. J. Roy Byerley ... 14

BIOLOGY TEACHING—METHODS
Forum? (Editorial). J. A. Trent ... 56
The Problem Child and the Biology Project. E. J. Beebe ... 74
An Objective Approach to Biology. Charles W. Gouget ... 81
Developing Individual Pupil Interests in Biology. K. B. Sanders ... 84
How Shall a High School Pupil Use a Biology Textbook? L. J. Fitzpatrick 105
A Handling of the Topic: Cheese. Edith A. Purer ... 125
Modeling in the Laboratory. M. Anthony Payne ... 181

BIOLOGY TEACHING—PHILOSOPHY
Biology for Contemporary Youth. Herbert A. Dwyer ... 22
"Of Our Making." D. F. Miller ... 25
The Importance of Biology Teaching for Secondary School Pupils. Paul Sears 67
Philosophy of Education for Biology Teachers. K. A. Sarafian ... 96
The Opportunity and Obligation of the National Association of Biology Teachers. O. Riddle ... 116
General Education and Secondary School Biology. F. L. Fitzpatrick ... 147

BIOLOGY TEACHING—SUPPLEMENTARY READING
Supplementary Reading in Biology. Helen D. Osborn ... 44

BIOLOGY TEACHING—TEACHER PREPARATION
A Program of Teacher-Education in Secondary School Biology Recommended by Teachers in Service. J. A. Trent 28
"What Would You Learn of Me?" (Editorial). B. B. Vance ... 100

BIOLOGY TEACHING—VISUAL AIDS
Advantages of the Micro-Projector in the Biology Classroom. Helen Trowbridge ... 10
The Use of Objects, Specimens, and Models in the Teaching of Science. Elwood D. Heiss ... 42
The Use of Flat Pictures in the Teaching of Biology. Elwood D. Heiss ... 108
A Simple Micro-Viewer. Philip Goldstein ... 122
The Still Camera in Biological Presentations. L. C. Oglesby ... 131

BOOK REVIEWS
Biological Abstracts. Reviewed by G. W. Hunter, III ... 195

For a pupil-motored course...

EVERYDAY PROBLEMS IN BIOLOGY

Pieper—Beauchamp—Frank

A logical sequence of twelve units in which the pupil by observation, experimentation, and problem solving works out a well-rounded picture of the biological aspects of life around him.

Pupils' Study-Books, Objective Tests, and detailed free Teacher's Guidebooks furnish a complete program of teaching aids.

Write for further information.

SCOTT, FORESMAN AND COMPANY

Chicago Atlanta Dallas New York

From the Laboratory of

PROF. I. V. PAVLOV

(Nobel Prize Winner)

Comes a Study Unsurpassed In Thoroughness on the Subject of

The Nervous System

A 16mm Silent Film in 5 Sections

1st Section — The Development of the Nervous System in Vertebrates and Invertebrates. 2 Reels

2nd Section — Reflex Action: Development of Neurons; Function of Motor Nerve; Responses to Stimulation; Etc. 1 Reel

3rd Section—The Spinal Cord: Study of the Function of the Spinal Cord 2 Reels

4th Section—The Brain: Structure and Function. 5 Reels

5th Section—The Study of Conditioned and Unconditioned Reflex Behavior in Different Organisms. 4 Reels

Sale—$24.00 per reel
Rental—$ 2.00 " "

For Arrangements Write: Dept. B

GARRISON FILMS 1600 BROADWAY NEW YORK CITY

INDEX—Vol. 1

PAGE

Compton, R., and Nettles, C. H., "Conquest of Science." Reviewed by E. D. Heiss 193

Davis, Watson, "The Advance of Science." Reviewed by L. R. Hastie 194

De Kruif, P., "The Fight for Life." Reviewed by M. D. Campbell 47

Dobell, C., "Anthony Leeuwenhoek and His 'Little Animals.'" Reviewed by R. C. Benedict 163

Fasten, N., "Principles of Genetics and Eugenics." Reviewed by S. W. Roberts 164

Fox, H. M., "Biology." Reviewed by E. D. Heiss 61

Gilbert, M. C., "Biography of the Unborn." Reviewed by E. M. Hibbs 140

Gregory, Sir R., "Discovery of the Spirit of Science." Reviewed by L. R. Hastie 111

Herrick, F. H., "Wild Birds at Home." Reviewed by E. D. Heiss 46

Huntington, E., "Tomorrow's Children." Reviewed by E. D. Heiss 140

Leakey, L. S. B., "Adam's Ancestors." Reviewed by E. D. Heiss 61

Melander, A. L., "Biological Terms." Reviewed by J. A. Trent 141

Miller, D. F., and Blaydes, G. W., "Methods and Materials for Teaching Biological Sciences." Reviewed by H. J. Mank 162

Palmer, R., "Living Things, an Introduction to Biology." Reviewed by M. C. Lichtenwalter 165

Progressive Ed. Assn., "Science in General Education." Reviewed by E. D. Heiss 112

Rosendahl, C. O., and Butters, F. K., "Trees and Shrubs of Minnesota." Reviewed by E. D. Heiss 141

Spemann, H., "Embryonic Development and Induction." Reviewed by L. A. Rider 60

Swingle, D. B., "Plant Life." Reviewed by E. D. Heiss 62

Walter, H. E., "Genetics." Reviewed by E. D. Heiss 60

BOOKS

Supplementary Reading in Biology. Helen D. Osborn 44

How Shall a High School Pupil Use a Biology Textbook? L. J. Fitzpatrick 105

A Plan for Biology Textbook Reviews. Alan A. Nathans 161

CAMERA, The Still —— in Biological Presentations. L. C. Oglesby 131

CLUBS

A Stimulus for Club Growth (Editorial). I. A. Herskowitz 36

Story of a Biology Research Club. Lucy Orenstein 103

EMBRYONIC MATERIAL for Laboratory Experimentation. Roberts Rugh 184

GENETICS

Drosophila in the Laboratory. Catherine V. Beers 49

LABORATORY, The Modern Biology ——. J. R. Byerley 14

For fundamental ideas in the field of Science

SCIENCE AND LIFE

presents a wholly integrated program in science instruction for grades seven, eight, and nine—foundation general science at its best. The first four books form one cycle for the seventh and eighth years. The last two books provide the second cycle which recapitulates and further develops science concepts in the ninth year.

This new science program is planned for the average student with a minimum of teacher help. For variation in pupil abilities, *Supplementary Activities* to each Unit include: Demonstrations and construction problems, Problem Questions, and Reports and discussions. Following each problem into which the Units are divided is a test for comprehension and review. These six books are simply, engagingly written and fully illustrated to create a genuine, comprehensive foundation in science knowledge.

SCIENCE AND LIFE

by Frank Reh
Principal Sumner Junior High School, New York
and Frank M. Wheat
Chairman Biological Science, George Washington High School, New York

AMERICAN BOOK COMPANY

NEW YORK CINCINNATI CHICAGO BOSTON ATLANTA

WHY ABSTRACTS?

A good abstract:

"(1) enables the reader to determine whether or not a paper is of sufficient interest to him to warrant his reading it;

(2) it enables the teacher and general reader to keep themselves informed on the trend of current biological investigations with a minimum of effort; and

(3) it enables any reader to peruse the article more intelligently than he could otherwise."

(Smith, R. C., Jour. Ec. Ent. 31 (5): 564. N 11, 1938.)

USE BIOLOGICAL ABSTRACTS

A non-profit service by biologists for biologists, a modern necessity for every biology department library. Are you primarily a zoologist, botanist, geneticist, bacteriologist? Subscribe personally for your special section and keep up with progress. Complete annual index goes to every section subscriber.

Send your order now!

BIOLOGICAL ABSTRACTS, **University of Pennsylvania, Philadelphia, Pa.**

Enter my subscription to: ☐ BIOLOGICAL ABSTRACTS (Vol. 13, 1939) at $25, postpaid.
Abstracts of ☐ General Biology at $4.* ☐ Experimental Animal Biology at $9.*
☐ Microbiology and Parasitology at $5.* ☐ Plant Sciences at $6.* ☐ Animal Sciences at $6.*

Name ..... *Address* .....

* Add 50¢ per section postage to foreign subscriptions.

INDEX—Vol. 1

PAGE

LIGHT As a Limiting Factor for Aquatic Animals and Plants. George L. Clarke 150

MICRO-PROJECTOR, Advantages of the —— in the Biology Classroom. Helen Trowbridge 10

MICRO-VIEWER, A Simple ——. Philip Goldstein 122

MIGRATION, The —— of Fishes. George W. Jeffers 70

OSMOSIS

Osmotic Forces in Living Organisms. S. A. Corson 31

PEDAGOGIA

(Abstracts from the Literature.) T. F. Morrison 55, 80, 155

POISON OAK, Poison Ivy, or Poison Sumac, Sodium Hypochlorite for ——, Public Pest Number One. G. R. Johnstone 77

PROBLEM CHILD, The —— and the Biology Project. E. J. Beebe 74

REPRODUCTION

The Migration of Fishes. George W. Jeffers 70

SCIENCE and the World Crisis. Edwin G. Conklin 171

SCIENCE TEACHING—PHILOSOPHY

Formative Teaching. Guy F. Williams 53

SCIENCE TEACHING—VISUAL AIDS

The Use of Objects, Specimens, and Models in the Teaching of Science. Elwood D. Heiss 42

SEX EDUCATION with the Aid of Parents. P. K. Houdek 156

TEACHING AIDS in Biology. Marcus Lilling 188

TECHNIQUE

A Culture Medium for Black Mold of Bread. M. S. Briscoe 78

Culturing Invertebrates 189

Visualization of the Vertebrate Skeleton in the Entire Specimen by Clearing and Selective Staining. Alden B. Dawson 91

Making Smoke Prints of Leaves. C. A. Barker 101

The Vivarium. Helen Trowbridge 188

VIRUSES in Plants. L. M. Black 175

(Continued from page 174)

aims will not be reached by ordinary classroom or laboratory work in preparation for the ordinary examination, but they should come as a by-product of such work if it is conducted in the spirit of real science, by teachers who themselves are exemplars of this spirit. Education is habit-formation rather than information; illumination rather than indoctrination, inspiration rather than compulsion. "Whether there be tongues they shall cease, whether there be knowledge it shall vanish away, but now abideth faith, hope and charity"—in short, habits and character.

Biology Teaching Aids

Thirty-one Instructional Sound Film Subjects Produced in Collaboration with Leading Subject Matter Specialists Now Ready

PLANT LIFE SERIES

Plant Growth, Roots of Plants, Leaves, Flowers at Work, Seed Dispersal, Fungus Plants, The Dodder, Plant Traps.

ANIMAL LIFE SERIES

The Frog, How Nature Protects Animals, Beach and Sea Animals, Tiny Water Animals, Butterflies, Moths, Beetles, Pond Insects, Aphids, The House-Fly, Spiders, Birds of Prey, Thrushes and Relatives, Animal Life, Reactions in Plants and Animals.

PHYSIOLOGY SERIES

Mechanisms of Breathing, The Heart and Circulation, Body Defenses Against Disease, The Nervous System, Reproduction Among Mammals, Digestion of Foods, The Alimentary Tract, Heredity.

Others are to be Prepared

Write for Descriptive Literature

ERPI CLASSROOM FILMS INC.
35-11 Thirty-Fifth Ave.
Long Island City, N. Y.

BRING THE WORLD TO THE CLASSROOM

GENETICS CHARTS

A series of eight Heredity and Genetics subjects has been added to the growing series of Turtox Class Room Charts. These are based upon actual crosses made with lady-bird beetles, guinea pigs, peas and corn. They provide excellent demonstrations for presenting the fundamentals of Mendels law.

Chart size 17 x 22 inches reinforced and punched for hanging. The Price is only 50 cents each.

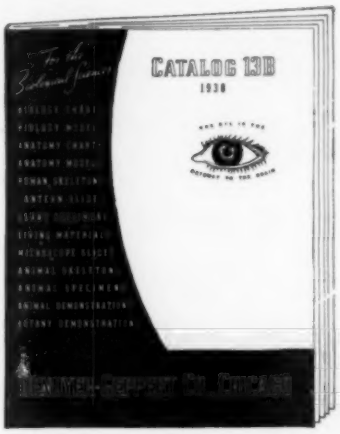
GENERAL BIOLOGICAL SUPPLY HOUSE
Incorporated
761-763 EAST SIXTY-NINTH PLACE
CHICAGO

REQUISITION TIME . . . . .

The Catalog shown here contains a wide selection of teaching helps for Biology, Botany, Zoology, Physiology and Health.

Anatomy and Biology Models, Charts, Slides, Specimens and Demonstration Mounts for every teaching need are illustrated, described and priced.

Use this Catalog in selecting items for purchase and for your spring requisition. Additional information gladly supplied. Write to



DENOYER-GEPPERT COMPANY

5235 Ravenswood Avenue **Chicago, Illinois**

POWERS & POWERS
High Grade Microscopic Preparations
Send for Illustrated Catalog
Lincoln, Nebraska

LIVING INSECT PARASITES
Demonstrate Nature's Balance
Breeding methods adapted for classrooms
No special equipment required
CALIFORNIA INSECTARIES, INC.
1612 W. Glenoaks Blvd. Glendale, Calif.

THE NATIONAL ASSOCIATION OF BIOLOGY TEACHERS ☐ NEW
MR. P. K. HOUDEK, *Sec'y-Treas.* ☐ RENEWAL
ROBINSON, ILLINOIS

I hereby apply for membership in The National Association of Biology Teachers and enclose $1.00 as my annual membership dues 80c of which is for a year's subscription to The American Biology Teacher.

M

Please Print Name

Street and Number

City and State

SCHOOL .....

POSITION .....

Local biology teachers association of which I am a member .....

Moon and Mann's

BIOLOGY

1938 Edition

THOROUGH
LIVELY
UP-TO-DATE

PROGRESSIVE
EASY
TEACHABLE

Write for a chart showing the
inexorable logic of its organization

HENRY HOLT AND COMPANY, INC.

New York Atlanta Chicago Dallas San Francisco

QUALITY BIOLOGICALS

prepared
by

THE ALDEN H. FORBES LABORATORIES

1710 Renton Avenue, West View,
Pittsburgh, Pennsylvania.

•

If you haven't received our catalog, write us today.

For the

Biological Sciences

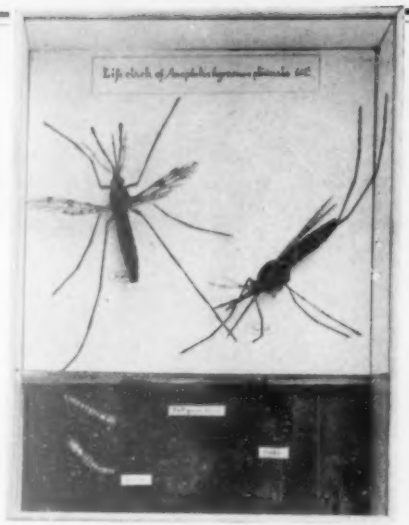
Models
Skeletons
Lantern Slides
Display Material
Preserved Material
Naturalists Supplies
Stains and Chemicals
Museum Preparations
Laboratory Glassware
Bird Skins and Mounts
Dissecting Instruments
Bacteriological Reagents
Microscope Slide Preparations
Charts, Botanical and Zoological
Insect Life-histories and Collections
Microscopes, Microtomes and
Accessories

Prompt Service NYSSCO PRODUCTS *Quality Guaranteed*

New York Scientific Supply Co.

(Formerly N. Y. Biological Supply Co.)

111-113 E. 22nd St., New York, N. Y.



No. Z-769 DURABLE MODEL OF LIFE HISTORY OF THE MALARIAL MOSQUITO (ANOPHELES HYRCANUS)

Pressed paper models, mounted in a wooden case (12″ wide x 16″ high x 3½″ deep) with removable glass front. The preparation consists of greatly enlarged models of the adult male and female in characteristic positions, eggs floating on water (cellulose sheet) free swimming and full grown larvae, and pupa. Thus the life history of the mosquito is given with indications of habitat during the various stages. **Price each $15.30**

Also in the same type of execution as the above are:—

Z-756 Cockroach (Phyllodroma germanica)
Z-757 Body Louse (Pediculus corporis)
Z-758 Head Louse (Pediculus humanus)
Z-759 Bed Bug (Cimex lectularius)
Z-760 Clothes Moth (Tinea pellionella)
Z-761 Carpet Beetle (Anthrenus verbaci)
Z-762 Rice Weevil (Calandra oryzae)
Z-763 Mosquito (Culex pipiens)
Z-765 House Fly (Musca domestica)
Z-766 Human Flea (Pulex irritans)

Price each $15.30

No. Z1362 DURABLE MODEL OF CIRCULATORY SYSTEM OF THE FROG

A greatly enlarged model made of pressed paper covered wire, showing on one side a schematic illustration of the arterial system (red) and on the other side the venous system. The principal organs supplied are shown. Those who teach Frog Anatomy will want this model.

Each $27.00

The following are available in similar execution:

No. Z1721	Durable Model of Frog Circulation—**simplified execution**	Each $16.20
No. Z1728	Durable Model of Tadpole Circulation	Each $22.50
No. Z1626	Durable Model of Carp Circulation	Each $31.50
No. Z2218	Durable Model of Pigeon Circulation	Each $31.50
No. Z2219	Durable Model of Pigeon Circulation, **simplified execution**	Each $16.20
No. Z2442	Durable Model of Rabbit Circulation	Each $14.40
No. Z541	Durable Model of Circulatory and Nervous System of Shrimp	Each $18.00

Models make teaching easier

ADAMS

CLAY-ADAMS CO., INC.
44 EAST 23RD STREET, NEW YORK

Send for list BT62 on Zoology Models and Skeletons

A Spencer Microscope

especially designed for

Biology Studies

The Spencer No. 66 is designed, both as to construction and price, to meet the requirements of laboratory work.

It is a standard size instrument with optics identical to those offered on more expensive instruments. The mechanical parts are of the same high-grade workmanship.

Aside from the optics, the fine adjustment is the most important feature. It is of the micrometer screw type, unsurpassed for precision, delicacy and durability. A revolving disc diaphragm and concave mirror provide for control of illumination.

A dustfroof revolving nosepiece with dual conical bearings insures correct and permanent alignment of the objectives.

For a detailed description of this and other Spencer laboratory and classroom microscopes, write Dept. S58

Spencer Lens Company

MICROSCOPES
MICROTOMES
PHOTOMICROGRAPHIC
EQUIPMENT

SPENCER
BUFFALO
U.S.A.

REFRACTOMETERS
COLORIMETERS
SPECTROMETERS
PROJECTORS